

Concrete Masonry Construction *for* Enduring and Firesafe Structures

Concrete for Permanence

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Concrete Masonry Construction



The Boston Motor Mart. Architect, Ralph Harrington Doane,
Boston. 130,000 concrete masonry units were used as back-up for
the cast stone exterior.

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CONCRETE MASONRY CONSTRUCTION

YEARS of service have firmly established portland cement concrete as a leader in the construction field. Among its well known advantages are its proven fire resistive properties making it the accepted fireproofing material. Its ability to withstand weather and wear and tear in usage has made the term concrete synonymous with permanence. Watertightness and increasing strength are other well recognized attributes of this versatile material. With all these advantages, concrete because of its plastic nature when molded lends itself to the production of structures of great beauty. Numerous are the advantages of this age-old material—portland cement concrete.

Precast concrete building units possessing the desirable qualities inherent in portland cement concrete are rapidly growing in use and are being accorded the same popular reception as monolithic concrete. Concrete masonry is now widely

used to construct load-bearing walls, back-up, curtain walls and partitions for all types of buildings up to and including skyscrapers. It is being economically used as a fireproofing material for structural steel. The substantial fire retardant qualities of concrete masonry, demonstrated time after time in actual service, have been definitely established by fire tests at the Underwriters' Laboratories.

The demand for concrete masonry units is increasing in every building center. City and state building ordinances recognize the advantages inherent in these fire resistive units. The nationally-known Hoover Committee, in preparing building standards for safe, economical wall construction, recognized the merits of concrete masonry in its recommended building code which is being widely used as a guide to good construction.



Residence of Addison P. Minshall, Chillicothe, Ohio. Miller and Reeves, Architects, Columbus, Ohio. Portland cement stucco finish on concrete masonry walls.

Characteristics of Concrete Masonry

CONCRETE MASONRY is a term commonly used to denote an assembly of concrete block, concrete tile or concrete brick employed in building construction. The concrete building units used are precast either by the "tamped" or "cast" process. Reliable manu-



Typical concrete building units. The larger units are concrete block; the smaller ones are concrete building tile.

facturers using either process make building units of guaranteed quality, complying with the requirements of all local building codes. Where no building code exists, concrete building units are manufactured in compliance with the standards of the American Concrete Institute, reproduced in full on pages 40 and 41.

Concrete Block

Concrete block are made in several sizes and shapes. The standard 8 by 8 by 16-inch size is the most widely used. Laid up in a single thickness it produces a wall 8 inches thick and courses 8 inches high. The 8-inch height is equivalent to three courses of brick, a size relation which is found convenient in bonding block with the latter material. See page 26 for methods of bonding. Block are also made regularly in the 10 and 12-inch widths with 8-inch height and 16-inch length. Veneer and partition block can be had in 3, 4 and 6-inch widths. These are well suited for all non-bearing purposes. To facilitate construction, corner block, joist block, sills, lintels, and other

specials are generally made in dimensions to accord with those of the normal block used in the wall. Common types of block are shown on page 18.

The amount of air space in concrete block varies from 20 to 40 per cent of their volume, but in most common types it approximates 33 per cent. The tendency in recently designed types is to increase the proportion of air space to about 40 per cent, producing a lighter unit, easier to handle and quicker to lay.

Concrete Building Tile

Concrete building tile are smaller and lighter than concrete block. A larger proportion of their volume is air space, usually from 50 to 75 per cent of the gross volume. Tile are usually 12 inches long and 8 inches wide. Twelve-inch walls can be built with the same size units that are used in making 8-inch walls, merely placing the tile the other way in the wall. Heights of tile vary, units $3\frac{1}{2}$ inches and others 5 inches in height being in common use. One 5 by 8 by 12-inch tile is equivalent in volume to six common brick; one $3\frac{1}{2}$ by 8 by 12-inch tile to five common brick. One course of 5 by 8 by 12-inch tile is equal to two courses of brick in height. Three courses of the $3\frac{1}{2}$ by 8 by 12-inch tile are equal to four courses of brick. (See page 26.)

As in the case of concrete block, manufacturers regularly furnish fractional length tile, door and window frame jamb tile and other specials. Common types of concrete building tile and typical specials are shown on page 19.

Light Weight Concrete Units

Light weight concrete block and concrete building tile are also manufactured in standard sizes. They are marketed under various trade names such as "Cincrete," "Cinder Blox" and "Haydite" which are derived from the aggregates used in their manufacture,—cinders and burned shale.

Units made with light weight aggregates possess advantages other than a saving in weight. They afford good insulation against heat, cold and sound and provide an excellent plaster and nailing base.

Surface Finishes

Due to the variety of color and texture treatments available, there is a growing preference for portland cement stucco as a finish for concrete masonry construction. Several popular stucco finishes are described and illustrated in the chapter on portland cement stucco, pages 15 and 16. Suggested specifications for the application of portland cement stucco on concrete masonry walls are found on pages 42 and 43, and page 39 shows construction details.

The surfaces of concrete block and tile are sufficiently rough to provide a strong mechanical key for portland cement stucco. The uniform density of these units provides uniform suction, minimizing the possibility of blotching and the irregular behavior of color, both commonly due to variations in suction. Uniformity of texture which is characteristic of concrete masonry gives uniform mechanical bond which is equally as important as uniform suction. Portland cement stucco unites so closely with concrete masonry that once bonded it is practically impossible to separate the two materials.

Pleasing surface finishes can be given concrete block or tile by using selected colored aggregates in the facing material. For example, white marble with a sprinkling of black marble or green black copper slag gives a surface resembling natural marble. Buff pigments and graded marble chips with a sprinkling of micaspar produces a surface similar to limestone but with a life and sparkle resembling natural granite. Wide selections of textures and colors are available—including



Concrete masonry units are uniform in size and shape, making it easy for the mason to lay a true wall.

the entire range of marble, granite, colored sand and gravel and mineral pigments. In all of the resulting surfaces will be found the distinct and pleasing individuality of concrete.

Face brick, terra cotta, concrete or natural stone surfaces are often desired as an exterior finish, concrete block and tile serving admirably as a back-up for such material. Bond between the facing and the backing is secured by header courses of brick. See drawings on page 26.



In this attractive wall the masonry units are exposed.



Concrete masonry backing with portland cement stucco finish.

Concrete Masonry on the Job

Wall Thickness

Thickness of walls is often regulated by state or local building codes. Eight inches is usually specified as the minimum thickness for all exterior walls and for load-bearing interior walls. Partition and curtain walls are often made only 4 or 6 inches thick and certainly need not exceed these dimensions if supporting only their own

weight for short lengths with ordinary ceiling heights.

The thickness of bearing walls in heavily loaded buildings is properly governed by the limits of loading. The allowable working loads are commonly placed at 70 pounds per square inch of gross area when laid in a 1-1-6 cement-lime mortar, and 80 pounds per square inch when laid in a 1-3 portland cement mortar. In dwellings, private garages and other small buildings the actual loading of the units usually is much lower than this, frequently less than 40 pounds per square inch of gross cross-sectional area, but as mentioned above a minimum wall thickness of 8 inches has been commonly adhered to, regardless of load, largely for reasons of stability and convenience of construction. In industrial, office or school buildings or wherever long stretches of walls or high ceilings are necessary, added stability is secured by means of concrete masonry piers and pilasters built at intervals along the wall. Where great stability is required, as in buildings several stories high, concrete masonry piers and pilasters may be made solid by filling the cores of the units with concrete. See details, pages 21 to 24 inclusive.

The following table of wall thickness recommended in the Report of the Building Code Committee, U. S. Bureau of Standards, 1925, applies to residences and buildings up to four stories. In special cases the Bureau of Standards recommends a 12-inch wall throughout in four-story buildings. For these limitations, see Sec. 10 of the Recommended Ordinance for Concrete Block and Tile Construction on page 43.



Integrity Trust Building, Philadelphia. A. H. Lavalle, Springfield, Mass., Architect. A new skyscraper utilizing concrete masonry units for all exterior walls (backing for brick), interior partitions, elevator shafts and stair enclosures, and as fireproofing for all columns.

WALL THICKNESS

(Recommended Thickness of walls (in inches) of Residences and Buildings up to Four Stories in Height.)

No. of Stories	Basement	1st Story	2nd Story	3rd Story	4th Story
1	12	8
2	12	8	8
3	12	12	12	8	..
4	16	16	12	12	12

Mortar

It is recommended that portland cement mortar be used for laying concrete building units because of its great bonding power, compressive strength, density and resistance to weather. Cement mortar should be made with clean graded sand and clean water. Well slaked or commercially hydrated lime is usually added to make mortar more plastic or "fat." For ordinary work a mortar composed of one part portland cement, one part lime and not more than six parts of



Fireproofing for structural steel columns in the Integrity Trust Building was built with cinder concrete masonry.

sand (measured by bulk) is considered satisfactory. When mortar of maximum strength is desired or if mortar is to be used in laying fine face block, the amount of lime used should be limited to not more than 25 per cent of the volume of cement (approximately 10 per cent by weight, which amounts to about 10 pounds of lime to each sack of cement). Then the mortar is usually mixed in the proportion of three cubic feet of sand for each sack of cement and ten pounds of lime. Mortar should be mixed thoroughly with just enough water to give suitable plasticity. Thorough mixing improves the plasticity and workability of mortars, and less mixing water is required to obtain proper working consistency when time of mixing is increased.



Illustrating the use of "header block" in the Integrity Trust Building, where concrete units are used as backing for brick.

Colored Mortars

Only finely ground pure mineral pigments supplied by reliable manufacturers may be relied on to produce thoroughly satisfactory colored mortars. The amount of mineral color should not exceed 6 per cent by weight of the cement used, as larger quantities may affect the strength of the mortar. Successive batches of mortar must contain exactly the same proportions of cement, sand, coloring matter and water if exact color uni-



An interior view of the Integrity Trust Building, showing concrete masonry used for partitions and column fireproofing.

formity is to be maintained. A table indicating the mineral pigments to be used in coloring portland cement mortar will be found on page 16.

Footings and Foundations

Concrete footings and foundation walls must have sufficient strength to support the weight of the building safely and without settlement. When the foundation serves as a basement wall, strength to withstand the lateral pressure of the soil is necessary and it must also be watertight. In order to prevent possible upheaval by freezing, footings even for light structures such as porches or small garages must extend below possible frost penetration even though firm bearing soil is found at a shallower depth. The depth to which frost penetrates varies and may be as much as six feet in sections where winters are severe. When in doubt as to frost depths, inquiry should be made as to common practice followed in the locality.

Concrete footings should always be placed upon firm soil. If soft soil, loam or decaying matter is encountered it must be removed. The following table indicates the safe loads for various soils:

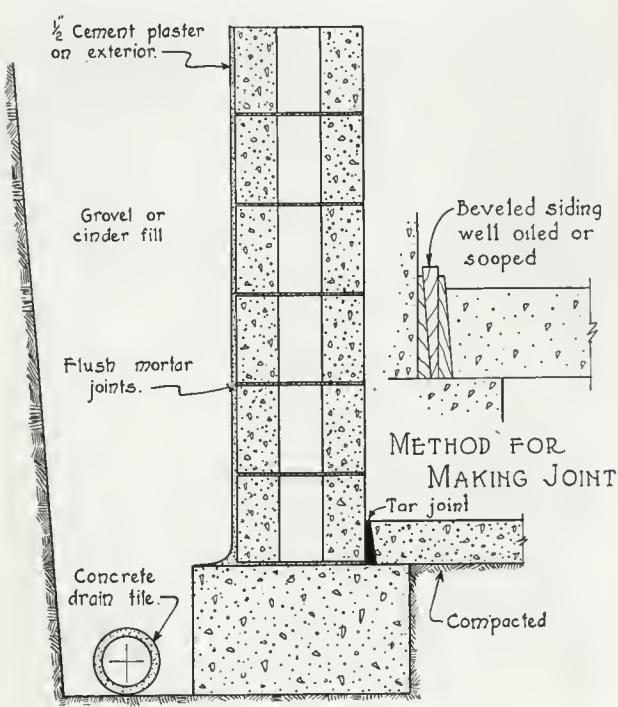
Character of Soil	Safe Load per Square Foot
Soft clay	1 ton
Wet sand	2 tons
Firm clay	2 tons
Fine and dry sand.....	3 tons
Hard, dry clay	4 tons
Coarse sand	4 tons
Gravel	6 tons

The width of properly designed concrete footings should be such that the soil is loaded with a weight no greater than it can safely carry without possibility of settlement. A footing 18 inches wide and 12 inches thick is usually sufficient for a small residence and many competent designers and builders use an assumed size such as this, in preference to figuring the weight of each house separately. However, the more painstaking method of procedure is to figure the weight in each case and establish the width of the footings accordingly.

Making Basement Walls Watertight

A dry basement is a positive essential of good construction. For ordinary well drained soils the most important precaution in building the concrete masonry walls below grade is to see that joints are well filled with cement mortar and carefully pointed. If the subsoil does not have good drainage, a line of concrete drain tile placed entirely around the outside of the footing and connected to a suitable outlet generally can be relied upon to carry off excess water. Care should be exercised to excavate to proper grade so that there will be a uniform slope to the tile line with no low places. The excavation above the drain tile should be filled to a depth of one or two feet with gravel, cinders or some other material of a porous nature through which water can seep easily. Backfilling may then be completed with earth, which is well compacted, and the surface sloped away from the structure. If for any reason it is impossible to run a line of tile around the outside, the tile may be placed on the inside of the footing and slightly below it.

If the soil is very receptive of moisture or the water level likely to rise much above the footing, special precautions are recommended. The usual treatment in either case is to apply to the exterior walls two or more coats of portland cement mortar mixed in the proportions of 1 sack of cement to 3 cubic feet of clean, well-graded sand. All



A dry basement wall built with concrete masonry.



Pontchartrain Hotel, New Orleans. Weiss & Dreyfous, Inc., Architects. 60,000 units of concrete tile were used for backing and partitions.

dirt and loose particles of mortar should be removed from the wall before the plaster is applied in order to obtain a strong, permanent bond.

Another common method of waterproofing is to coat the exterior surface with hot tar, pitch or other bituminous preparation, using a broom or fibre brush. The wall must be clean and absolutely dry when this coating is applied or it may not adhere perfectly. The plaster treatment is generally more satisfactory. In extremely wet soils builders sometimes use both treatments, applying the bituminous preparation on the plaster coating after it has hardened and the surface becomes dry. A recommended method of making ordinary basement walls watertight is shown on page 8. Deep basements and pits located below the water level present special problems requiring individual solution.

Basement Partitions

Basement partitions of concrete masonry are recommended for carrying the weight of the

floors and interior partitions as preferable to beams and columns, although for wide spans and heavy structures the latter are obviously necessary. The rigid support afforded by interior masonry walls insures a minimum settlement of the floors or interior partitions and consequently little if any cracking of plaster or loosening of interior trim occurs. Such walls afford fireproof enclosures for heating equipment and fuel, confine steam, moisture and odors, and provide insulation for fruit, vegetables or other perishables.

Concrete block and tile are frequently used for both load-bearing and non-load-bearing partition walls, also for fire wall enclosures. Standard units are used for load-bearing walls while special units from 3 to 6 inches thick are often used for partition walls that do not carry loads other than their own weight.

Setting Door and Window Frames

Door and window frames are usually built into the walls as the latter are laid. The frames should be well bedded and pointed in mortar. In high class work they are often caulked with oakum before pointing.

Door and window jamb block and tile are supplied to fit plank and box frames of all common designs and constitute one of the many convenient features of concrete masonry construction. By using these jamb block it is possible to make absolutely tight connections around the frames, excluding wind and water. Typical window details for both steel and wood frames are shown on pages 28 and 29.

Outside Fixtures

At the time concrete block or tile are laid, provision should be made for attaching downspout brackets, telephone and electric service wires and other house fixtures on the outside of the masonry walls. If the location of these fixtures cannot be determined as the walls are being built, it will be necessary to drill holes later. A simple manner to provide for such connections is to place short lengths of small lead pipe in the mortar joints into which expansion bolts may later be inserted. These inserts should extend outward so as to be flush with the finish stucco. Sometimes

the lead pipe inserts are hammered flat and wood screws used to hold the fixture. Several companies manufacture screw anchors for masonry walls.

Lintels

Precast lintels are generally more convenient and economical than lintels cast in place except possibly over wide spans where there may be a



A precast window sill.

saving in clamping forms to the wall and casting the lintel in place. Lintels are usually made the same height as the block courses. For example, if block 8 inches high and 8 inches wide are used, lintels are made 8 by 8 inches in cross-section and their length exactly equal to the wall length of one or more block. These lintels may be larger and stronger than required to carry the load in most cases, but the standardization of lintel sizes is a very great convenience in ordering and saves the time and the labor otherwise required to fit block around lintels of special dimensions. Reinforcement is always placed in lintels spanning openings of more than three feet, the steel bars being located about one inch above the bottom. Two half-inch bars are needed for a four-foot span and three for a five-foot span.

For use in connection with hollow concrete masonry walls to be furred and lathed on the inside, one-piece lintels having the same thickness as the wall are obtainable. For walls with a continuous air space for insulation, where interior plaster is to be applied directly to the masonry, lintels are "split" or made in two pieces to provide

an air space between inner and outer sections. Metal flashing may be placed over window heads in continuous air space walls.

Precast lintels are regularly given all the surface finishes common to concrete block using the same process of manufacture. Lintels cast in the wall can be made to match block by using similar facing aggregate in a thin layer of concrete next to the outside face. After forms are removed, the aggregate can be exposed by scrubbing with water or acid solutions or the surface can be tooled. No surface treatment except roughening is necessary when the surface is to be stuccoed.

Sills

Window sills are usually made from four to eight inches thick depending upon the height of the courses of block or tile with which the sills are made to conform. Sills are also varied in thickness to accommodate stock window frames which may be somewhat longer or shorter than a given number of courses of masonry. Variation in the height of openings is sometimes effected by forming a rebate in the lintel.

Window sills are usually precast like lintels. They should have a steep "wash" or slope to the weather. They should project at least 2 inches from the face of the wall and have a groove $\frac{5}{8}$ -inch wide and $\frac{3}{8}$ -inch deep, on the under side, to form a "drip" which keeps water from flowing over onto the face of the wall. They are often set at the time the wall is built. A better practice is to insert "slip-sills" after the wall has been laid up. If built in, only the ends are set in mortar, the bed joint being left open. It is filled and pointed after the walls have been finished.

Attachment of Sills and Plates

The usual method of attaching wood sills and plates to concrete masonry walls is to bolt them down at intervals, 6 feet apart or less, to the top course. Bolts should be about 10 inches long with nuts and large washers inserted in the air cells of the block or tile and filled around with concrete to insure firm anchorage. This method is much more satisfactory than spiking sills or plates to wall through mortar joints.

Gable Construction

Concrete block and tile walls should not stop at the plate level but should continue up in the gable ends of the building. Where walls are constructed of faced units, special angle cut lengths are required at the ends of the gable courses, but when the surfaces are stuccoed the triangular openings may be filled with monolithic concrete. This is done even though verge boards are made wide enough to cover these openings.

Chimneys

Good chimneys, whether located on the interior or the exterior of the building, should always rest on solid concrete footings extending well below maximum frost penetration and of sufficient width and thickness to carry the weight of the chimney without danger of settlement. When the chimney forms a part of the wall of a building, the chimney block must be securely bonded into it. Vitrified flue lining or fire brick flue lining, extending the entire height of the flue, is recommended by the National Board of Fire Underwriters.

Furring and Lathing

It is customary to "fur out" the lath and plaster on the walls of buildings of all masonry materials, and this should ordinarily be done



Protecting work during construction.

where concrete masonry is used. A continuous air space usually affords sufficient insulation so that plaster is about the same temperature as the inside air, preventing condensation. Special nails and screws have been devised for attaching furring strips. Sometimes small pieces of wood, often lath, are laid in the mortar joint flush with inside wall surface to afford facilities for nailing the strips. Attachments for furring strips are usually 3 feet on centers.

Prepared insulating material such as sheet cork, flax fiber and dried seaweed are sometimes used to line the interior wall, making it unnecessary to fur out the plaster. When these materials are to be plastered with portland cement plaster it is preferable that they be covered with metal lath or wire lath.

When masonry furring materials are used, such as concrete or clay furring tile, and also on walls constructed with special concrete units possessing high insulation value, plaster may be applied directly. Even under these conditions, furring may be advisable in severe climates in order to conserve heat. For all other types of concrete masonry construction, plaster should be furred out where placed on the walls of residences and other buildings to be continually occupied. In localities where experience has proven that it is safe to plaster directly on brick, tile or concrete walls, or for less important structures such as garages, industrial and farm structures where the atmosphere is generally dry and the possibility of a little condensation is of minor consequence, plaster is applied directly to the masonry.



Concrete building units are used in curtain walls of skeleton construction.

Protection During Construction

Concrete architectural stone sills and ornamental work, as well as protruding and especially exposed portions of walls, should have suitable protection during construction. Protecting portions of the work exposed to unusual danger of breakage or marring should be boxed in, since a covering of building paper does not afford sufficient protection.

Concrete architectural stone sills and ornamental work should be handled with the same degree of care and given the same protection that is ordinarily given to cut stone. Although damaged concrete can be repaired, considerable skill and experience is required to match original work. Clean wall and unsoiled and undamaged building trim are indications of skill and superior workmanship.

Cleaning Wall Surfaces

If a wall of faced concrete masonry has been soiled or stained during construction, it should be scrubbed with a stiff fibre brush and water. Serious stains may require scrubbing with a solution of muriatic acid varying in strength from about one part acid in ten parts water to one part acid in three parts water. The solution should be



Memorial M. E. Church, Baltimore, Md. A. C. Leach, Architect. Cinder concrete block were used as backing for the cast stone exterior.

allowed to remain on the surface until it stops bubbling. It should then be removed by thoroughly washing with clean water.

Firesafe Floors of Concrete Masonry

Structures with incombustible walls and floors are becoming more popular and today such construction is the approved and accepted type. The structural advantages of concrete floors are numerous. Besides firesafeness, their most important merit, they are entirely free from sagging, deflection or lateral movement and consequently



Sun room, Residence of W. B. Saul, Philadelphia. Simon & Simon, Architects. Concrete floor tile over fireproof first floor.

minimize plaster cracking on walls and ceilings. Most plaster cracks in dwellings are due to sagging or other movement of ordinary floors, exerting stresses in the walls which are then transmitted to the plaster. Concrete floors give greater rigidity to the structure, eliminating vibration caused by heavy city traffic or by movement within the building. They also provide greater stability, a feature of particular importance in areas subject to wind storms or earthquake shocks. A saving in wall height is effected by their use since the total thickness is less than wood joist construction.

Surface Treatment

The simplest form of surface treatment for concrete floors consists in giving the concrete a smooth trowelled finish, either plain or colored. Such a finish provides an excellent surface for rugs or other floor coverings. There are no ridges or other irregularities on a concrete floor which if present might cause uneven wear.

Another popular treatment for a plain concrete

floor consists of staining with suitable brown stain, then waxing with ordinary floor wax. The surface coat of the concrete floor is often marked off into squares or other patterns to resemble tiling. When colored in tones of dark red or green or brown or other desirable colors and subsequently treated with oil and filler, and waxed like hard wood, concrete floors assume the rich effect of old Spanish leather and provide an unsurpassed background for rugs and furniture. A concrete floor is impervious to moisture. In addition, very little effort is required to keep it clean, polished and good looking at all times.

Various other methods may be followed in finishing concrete floors. Terrazzo provides a surface with pleasing possibilities. Floor tile made of concrete are obtainable in a wide variety of styles and colors, to suit any desired interior color scheme. Wood flooring may also be used, being nailed to wood strips embedded in the concrete or secured with metal strips so embedded. Linoleum, one of the most commonly used floor coverings, is suitable for use in any room in the building and may be selected from a wide variety of designs available. Linoleum possesses resiliency and when laid according to approved specifications with felt underlay and with the joints cemented, is very serviceable.

Solid Slab Floors

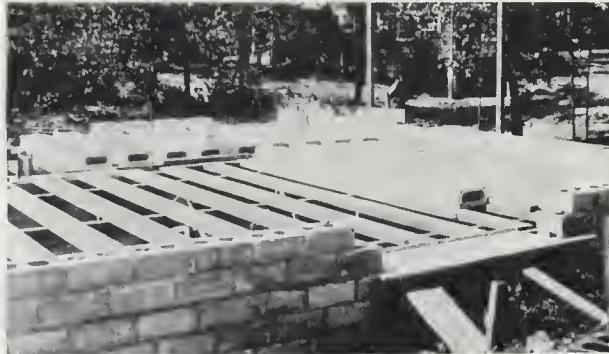
The solid slab type of construction for concrete floors consists simply of a reinforced slab of uniform thickness supported around the perimeter. While it requires somewhat more concrete than other types, it has the advantage of ease and simplicity in construction.

Concrete Ribbed Floors

In the construction of concrete ribbed floors, wood or metal is used to form concrete joists spanning the area at regular intervals. Joists are usually spaced at 24-inch intervals. A flat slab of concrete spans the distance between joists. Several types of steel forms are on the market suitable for this type of construction. The joists are reinforced with steel. Metal lath for plaster ceilings is attached below the joists by means of



Erecting forms for tile and joist concrete floor construction.



Forms with some of the tile fillers in place.

wires left projecting from the concrete or in the case of special steel forms may be anchored to the form flange.

Combination Floors

Concrete floors may be constructed with concrete block or tile used as fillers between concrete joists. This type of construction differs from the concrete joist type in that the space between joists is filled by the tile. The tile are left in place to form part of the completed floor. They add materially to its sound-proofing and insulating values and form an excellent base for the application of plaster to the under surface of the floor. The tile are easy to cut for pipes and conduits.

Supports of Concrete Floors

Common and satisfactory methods of supporting concrete floors on exterior walls of concrete masonry are shown on page 25. Metal or wire lath is laid over exposed openings in the block to prevent the concrete from falling into the air space below. The floor rests upon the inner half of the

wall section, veneer block being placed on the outer edge, with a small continuous air space left between the veneer block and floor slab. This type of construction is much superior to the practice sometimes followed of permitting the floor slab to extend over the entire width of the wall. If the slab is exposed on the exterior it is likely to detract from the appearance of the wall, and in case stucco is applied cracks are likely to appear when the slab expands or contracts.

Concrete floors requiring supports at points other than on exterior or interior walls are carried by reinforced concrete beams on concrete columns. Where main partition walls occur above, it is well to build partition walls below or when this is not feasible to place a reinforced beam under the floor directly below the wall, this beam in turn being supported on substantial concrete columns. Practically every concrete floor is an individual problem, requiring careful design and supervision. Typical construction details of concrete floors for residences where no span is greater than 16 feet are shown on pages 33 to 37 inclusive.



Steel reinforcing placed in joists between rows of tile give tensile strength.



View of basement ceiling shows joist and filler tile after forms are removed.

Portland Cement Stucco on Concrete Masonry

The use of stucco or plaster dates back to the early history of mankind. Examples are found among the ruins of buildings constructed by the early Egyptians, by the Greeks, and later by the Romans. The Romans used stucco on the exterior of the first Pantheon, and broken slabs of stucco, still intact, have been found in the ruins of Pompeii and Herculaneum.

Materials

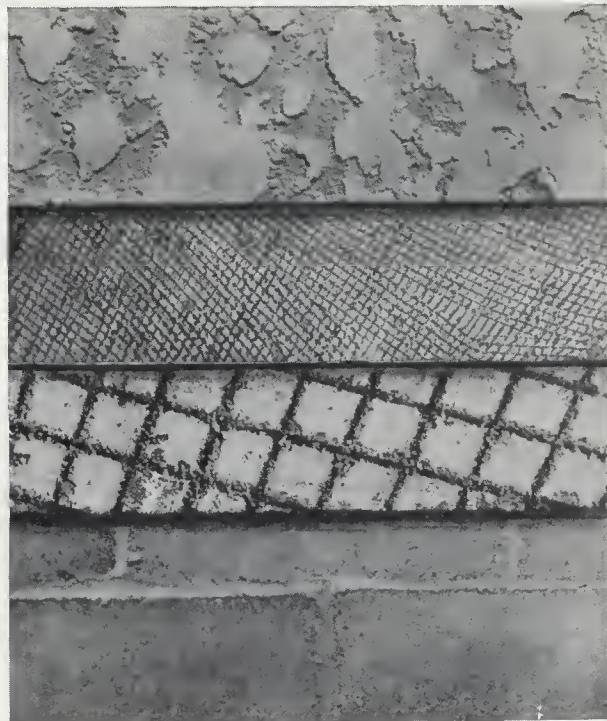
Modern portland cement stucco consists of a mixture of portland cement, aggregates and water. Aggregates consist of clean sand, screenings from crushed stone, or both, graded from fine to coarse. Various colors in stucco are obtained through the use of high grade mineral pigments added to the finish coat mortar.

The Owner and the Architect

Portland cement stucco is a material on which the owner and architect easily agree. The owner may indicate the color and texture he wants, perhaps one he has seen on an existing building. The architect is able to produce the results demanded because of the variety of stucco textures and colors available, one of which is certain to meet requirements.

Craftsmen skilled in applying plaster have made exhaustive studies of portland cement stucco both on the job and in the laboratory, developing methods that insure thoroughly successful results. They have learned that the stucco must be composed of good materials properly proportioned and carefully mixed; that these materials must be correctly applied to a suitable base; and that they must be applied by craftsmen having a full knowledge of the material.

There are many qualities in portland cement stucco making it desirable as a construction material. It is durable and age increases its strength and density. It is watertight and is not injured by frost. It does not cause colors to fade or metal to rust. It resists fire. It has sufficient plasticity and hardens slowly enough to permit workmen to produce any desired texture. The best quality of



A permanent stucco on a permanent backing. Portland cement stucco adheres readily to concrete masonry. The freedom from irregularities means economy of stucco materials.

material and workmanship can be had at moderate cost.

Application of Stucco to Concrete Masonry

Portland cement stucco bonds perfectly with concrete block or tile walls. This is because the units are made of the same kind of materials and provide both physical anchorage and the right amount of suction.

Concrete masonry walls should be dampened evenly just before applying the stucco in order to insure uniform suction. Various portions of the wall must draw moisture evenly from the stucco, so that the finished job will be of uniform color.

The scratch coat should be $\frac{3}{8}$ -inch thick and carried the full length of the wall or to natural breaking points like doors, windows or belt courses. The scratch coat should be trowelled on hard and tight, being forced into surface depressions to obtain a permanent bond. Before

the scratch coat hardens it should be deeply cross-scratched to provide mechanical key for the brown coat. The scratch coat must be damp cured for 2 days and then allowed to become dry before the brown coat is applied.

Before starting to apply the brown coat the surface of the scratch coat must be dampened evenly to provide uniform suction. The brown coat is approximately $\frac{3}{8}$ -inch thick and should be brought to a true and even surface and then left rough enough to provide a bond for the finish coat. A wood float is used for finishing the brown coat.

The brown coat must be damp cured for 2 days and then allowed to become dry before the finish is applied. Uniform suction is then secured by uniform dampening just before applying the finish coat.

The finish coat is usually from $\frac{1}{8}$ -inch to $\frac{1}{4}$ -inch thick, thickness depending on the texture used.

As in the case of the scratch and brown coats, the finish coat must be kept damp continuously for at least 2 days in order to insure correct curing.

Color Pigments in Stucco and Concrete

Only high grade mineral pigments should be used for coloring stucco. Such pigments will have highest color value and their use is recommended because less of the pigment is required to

produce the desired results. Aniline base color and other organic dyes should not be used in stucco as they are likely to fade.

Proper proportions of color pigment to produce a desired shade should be determined by experiment. In general, the amount of coloring material will not exceed 6 per cent of the weight of the cement. White finishes are obtained by using white portland cement and light colored aggregates. For all of the lighter colors white cement and light colored aggregates are necessary in the finish coat.

A general guide to the selection of mineral pigments to obtain various color effects in portland cement stucco follows:

For *brown*, use burnt umber or brown oxide of iron. Yellow oxide of iron may be added to obtain modification of this color.

For *buff*, use yellow ochre or yellow oxide of iron. Red oxide of iron may be added in limited quantities.

For *gray*, use small quantities of black iron oxide, Manganese black or Germantown lamp black.

For *green*, chromium oxide. Yellow oxide of iron may be added.

For *pink*, use small quantities of red oxide of iron.

For *rose*, use red oxide of iron.

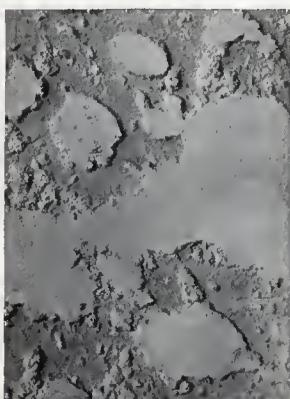
For *cream*, use yellow oxide of iron in small quantities.

For *white*, use white portland cement.

Stucco Information on Request

The variety of stucco finishes available is explained and methods of application described in a booklet available on request.

A Few Examples of Stucco Finishes



MODERN AMERICAN POLYCHROME

The smooth base coat partially covered with troweled rough-cast mortar of another color.



ENGLISH

A surface marked with short, irregular trowel strokes and while still plastic, lightly rubbed with burlap.



ITALIAN

Random troweling reduces the irregularities of this rough-torn surface.



FRENCH BRUSH

A brush is used to soften the sweeping, semi-circular trowel marks.

Fire-Resistive Roof Coverings

Underwriters' statistics show that inflammable roof coverings are responsible for over 20 per cent of dwelling house fires. This loss could be entirely eliminated by using concrete roofing tile or cement asbestos shingles.

Concrete Roofing Tile

Concrete roofing tile has been in general use in Germany and the Scandinavian countries for many years. In America this type of roof covering has grown in popularity and today concrete roofing tile suitable to industrial buildings or residences are available in practically every market. There are three common types for industrial buildings, the interlocking, flat slab and channel. Among the types in common use for residence roofs are the Spanish and French, and more recently has been added a type known as the "English shingle." The "Mission" type also has proved popular in some sections.

Roof tile for industrial structures are produced in large units, for use directly over open frame work, usually steel. The tile commonly come in 24-inch widths. Length varies from 4 to 9 feet and the slabs are from 1 to 1½ inches thick. These tile are commonly reinforced with steel. They are used extensively on pitched and sawtooth roofs and the channel types are especially suitable for use on long spans in flat slab construction.

Concrete roofing tile for residences and similar structures are produced in several standard sizes, averaging 9 by 15 inches (overall dimension). They lay approximately 8 by 12 inches to the weather. They are commonly sold by the square

(100 square feet) installed on the roof. With sizes adhering closely to the standard, 150 tile are required per square. Tile of the dimensions given weigh approximately 5½ pounds each.

Concrete tile are made in a variety of colors—red, green, gray, slate, copper, bronze, brown and purple, with the first three predominating. The roof can be laid in solid color tones, or variegated effects can be secured through the use of various color combinations.

Typical construction details showing methods of applying the French and Spanish types of concrete roofing tile are shown on page 32.

Cement Asbestos Shingles

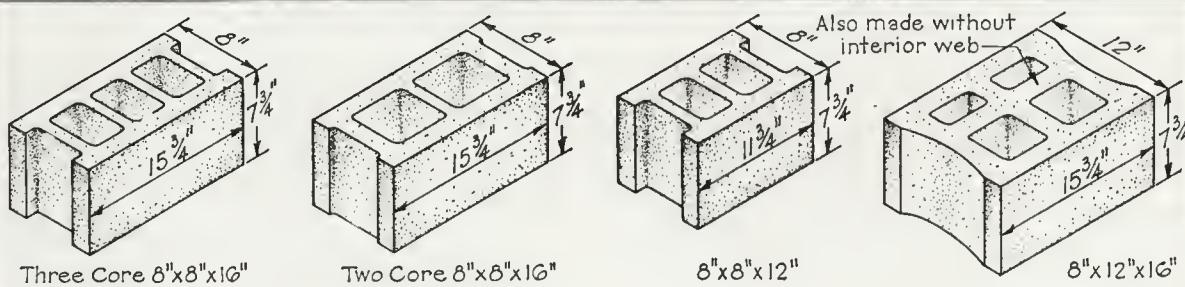
Another important type of fire-resistive roof covering is the cement asbestos shingle. Shingles of this type are composed essentially of portland cement and asbestos fiber, about 85 per cent of the content being portland cement.

Cement asbestos shingles are approximately 3/16-inch thick. They average in weight about 435 pounds per square (100 square feet) for the American type and about 275 pounds per square for the French or diagonal type. They are made in a variety of shades but are commonly furnished in standard colors of grays, reds, browns, dark slate and green. They are available in various shapes, the most common of which are rectangular and diamond shaped shingle forms. The recommended methods of laying asbestos shingles, together with the different shapes required for each method, are illustrated on page 32. Their application to any roof involves no difficulty. Roofers can lay them rapidly.

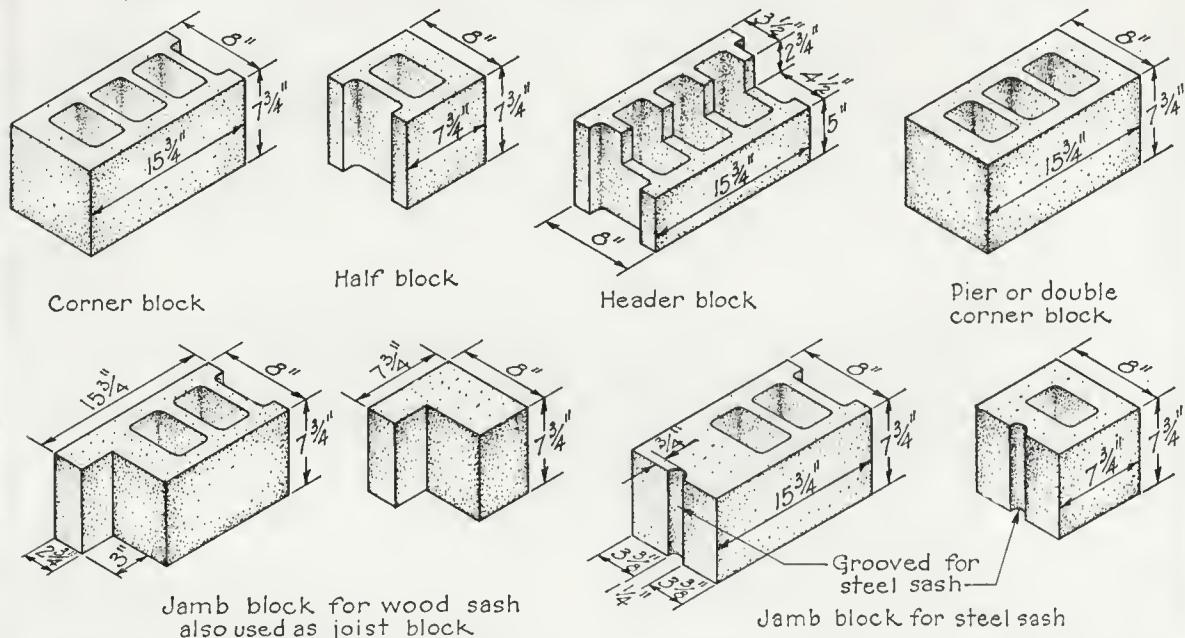


Attractive roof coverings of concrete roofing tile and cement asbestos shingles.

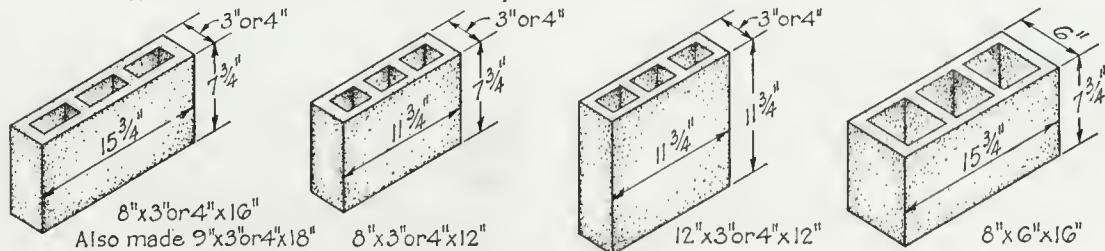
CONSTRUCTION DETAILS



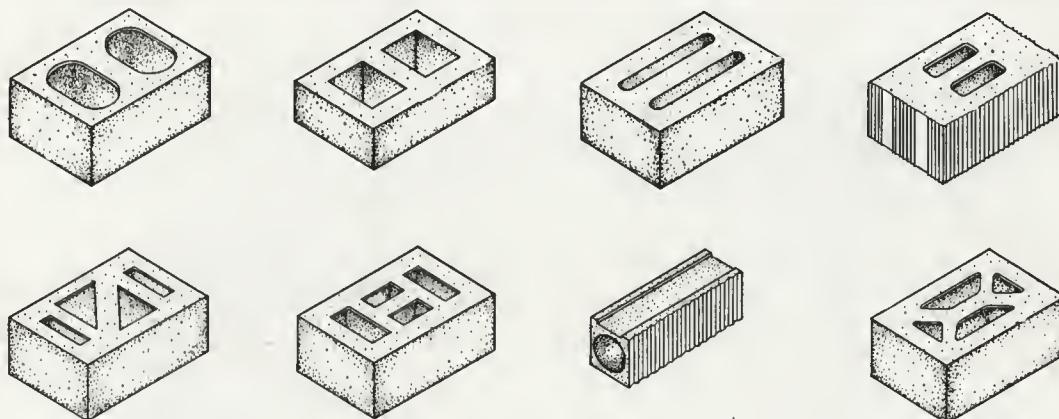
TYPES OF CONCRETE WALL BLOCK - STRETCHERS



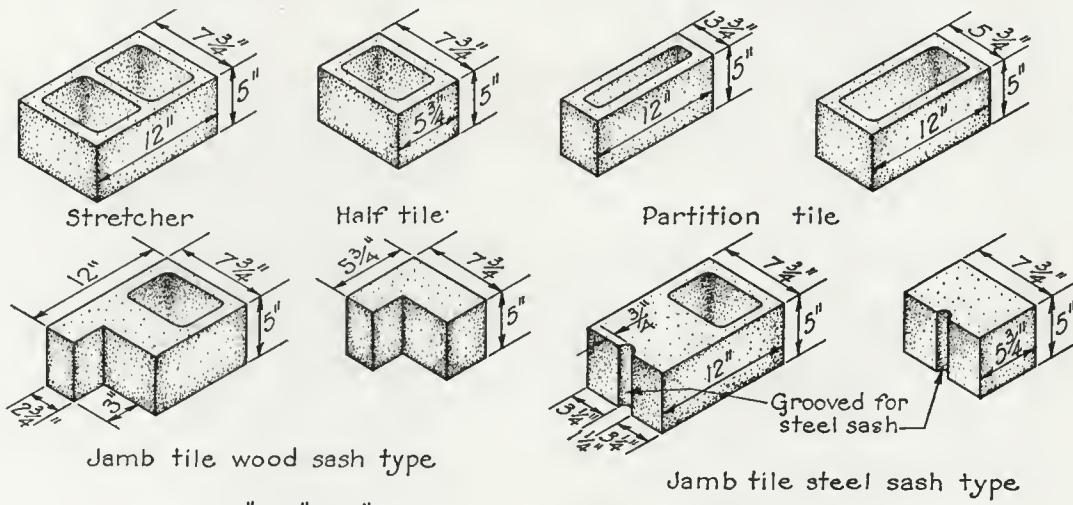
STANDARD SPECIALS FOR 8" BLOCK, ALSO MADE IN THE TWO CORE TYPE SIMILAR SPECIALS ARE REGULARLY FURNISHED FOR 12" BLOCK



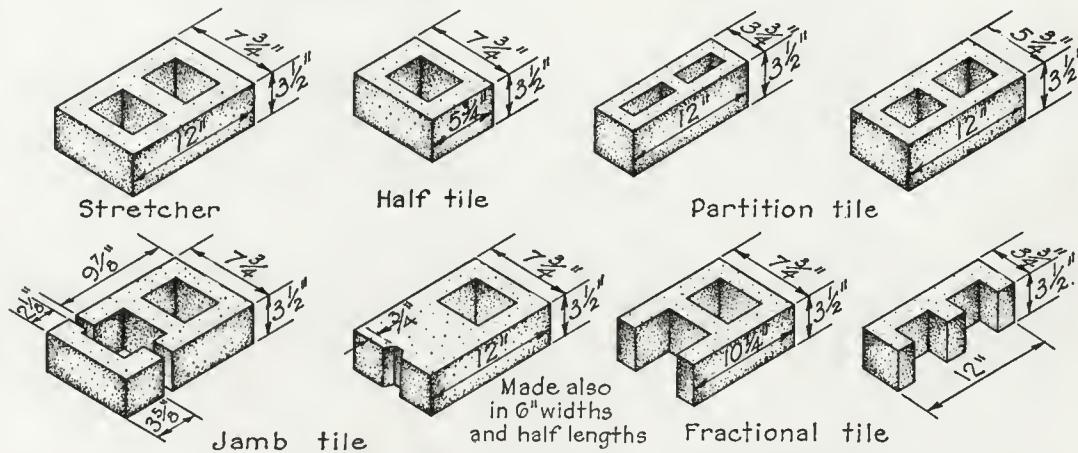
THREE CORE TYPE OF PARTITION BLOCK
SIMILAR UNITS ARE OBTAINABLE FOR THE TWO CORE TYPE OR IN SOLID UNITS



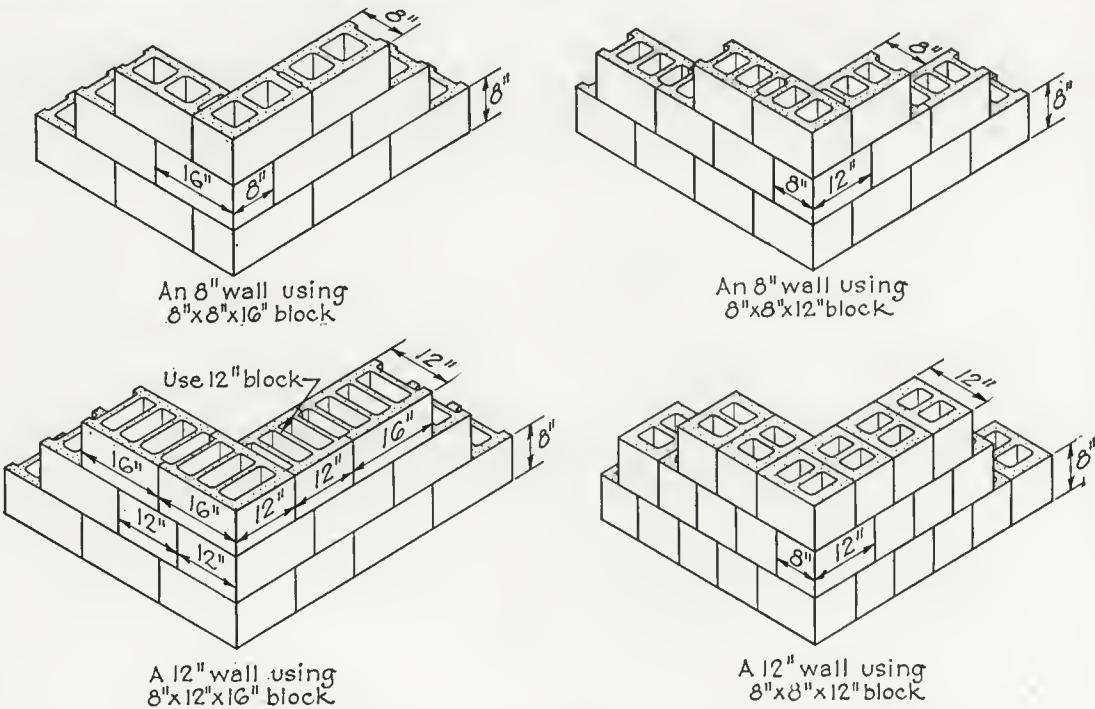
COMMON TYPES OF CONCRETE BUILDING TILE



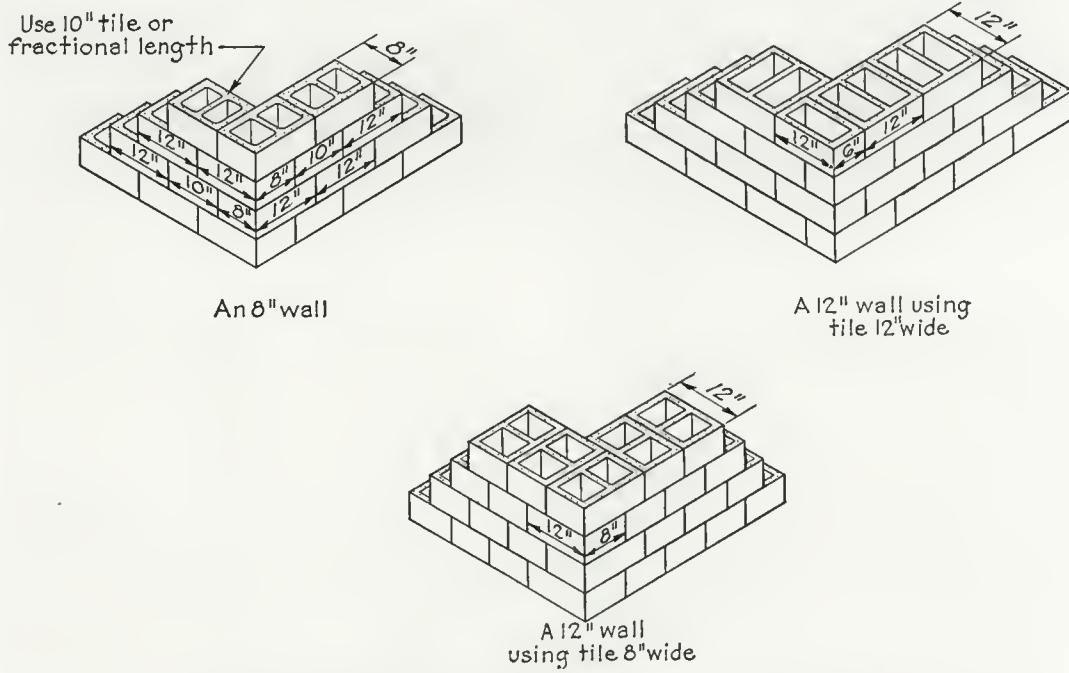
5" x 8" x 12" TILE WITH SPECIALS



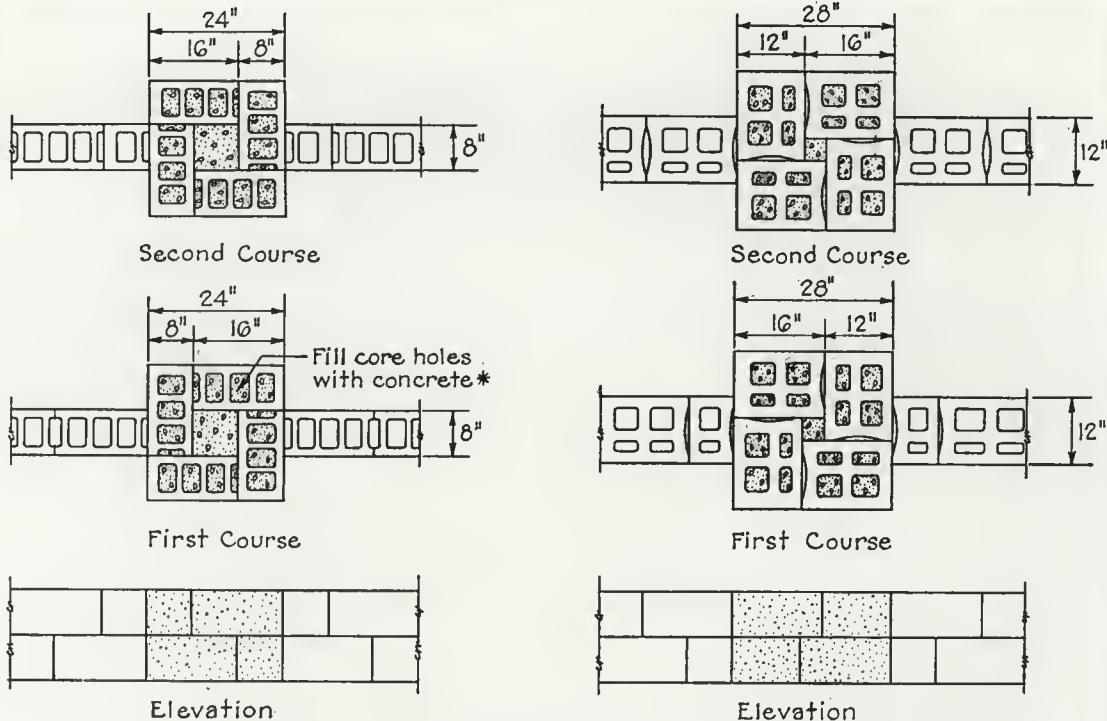
3 1/2" x 8" x 12" TILE WITH SPECIALS



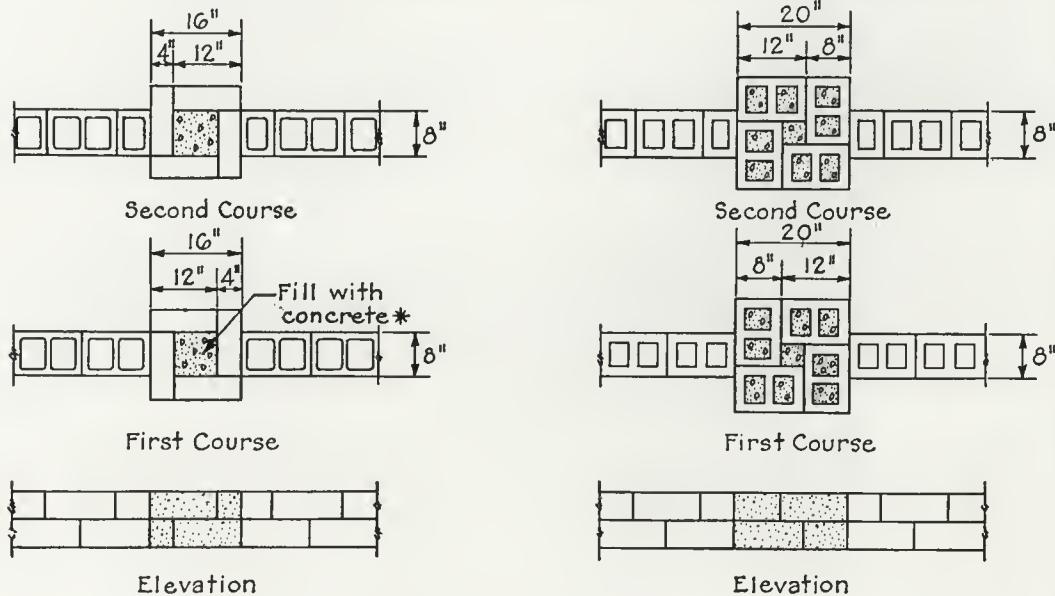
CORNER CONSTRUCTION WITH CONCRETE BLOCK



CORNER CONSTRUCTION WITH CONCRETE TILE

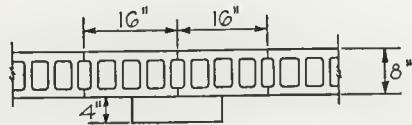


PIER CONSTRUCTION WITH CONCRETE BLOCK

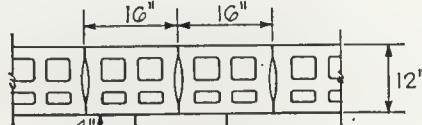


PIER CONSTRUCTION WITH CONCRETE TILE

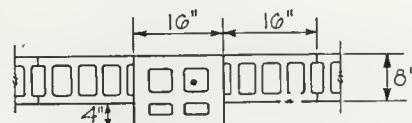
* See Section 13 of Recommended Building Ordinance for Concrete Block and Tile



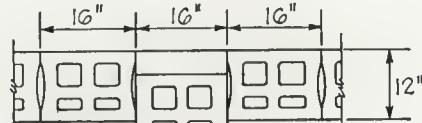
Second Course



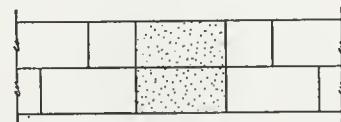
Second Course



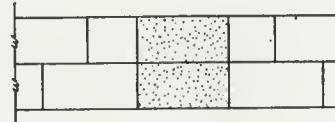
First Course



First Course

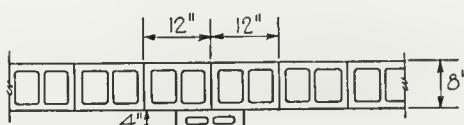


Elevation

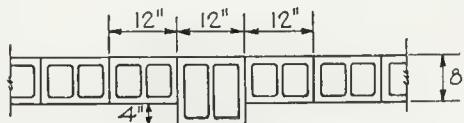


Elevation

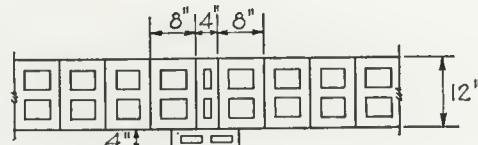
PILASTER CONSTRUCTION WITH CONCRETE BLOCK



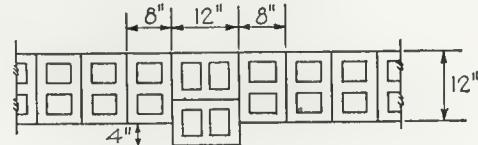
Second Course



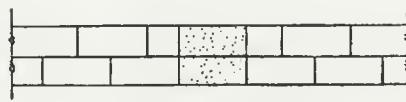
First Course



Second Course



First Course

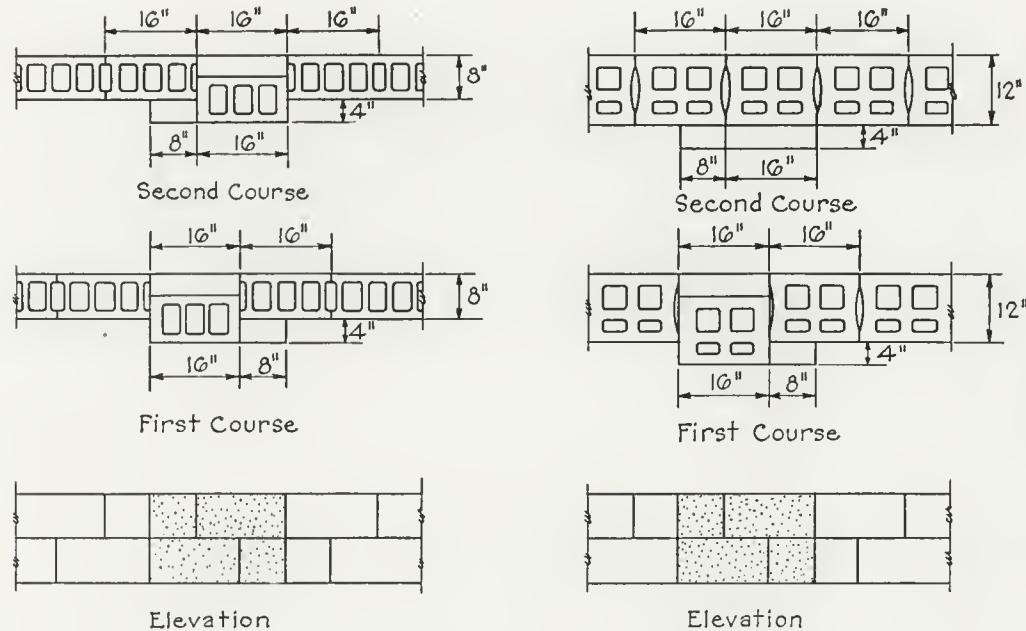


Elevation

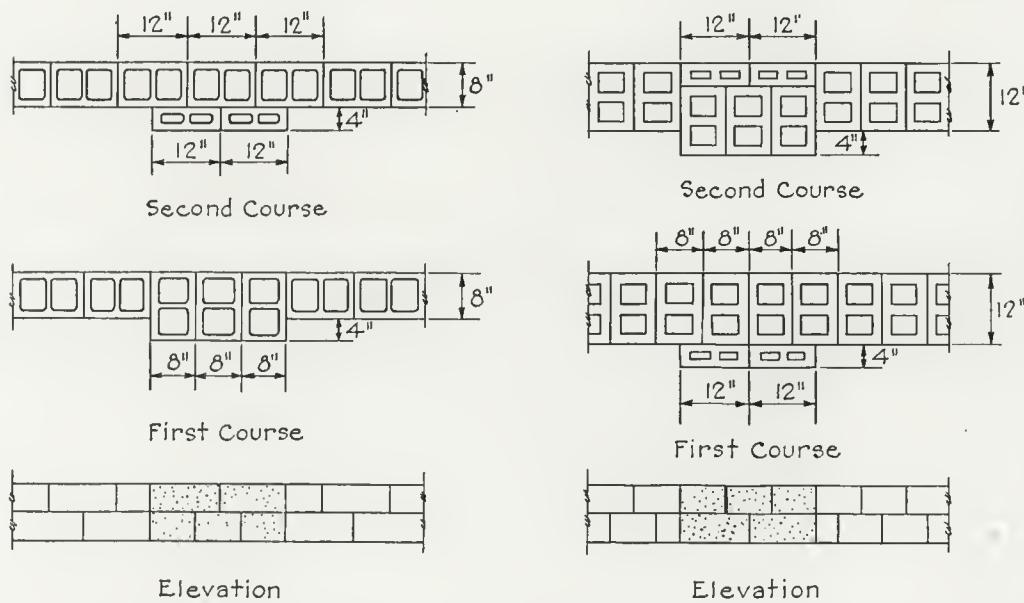


Elevation

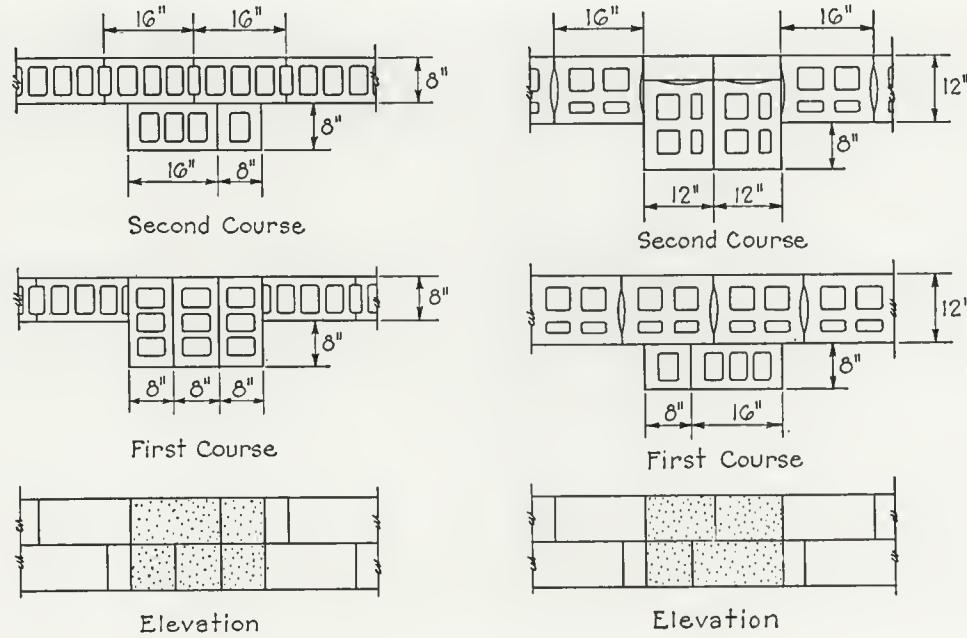
PILASTER CONSTRUCTION WITH CONCRETE TILE



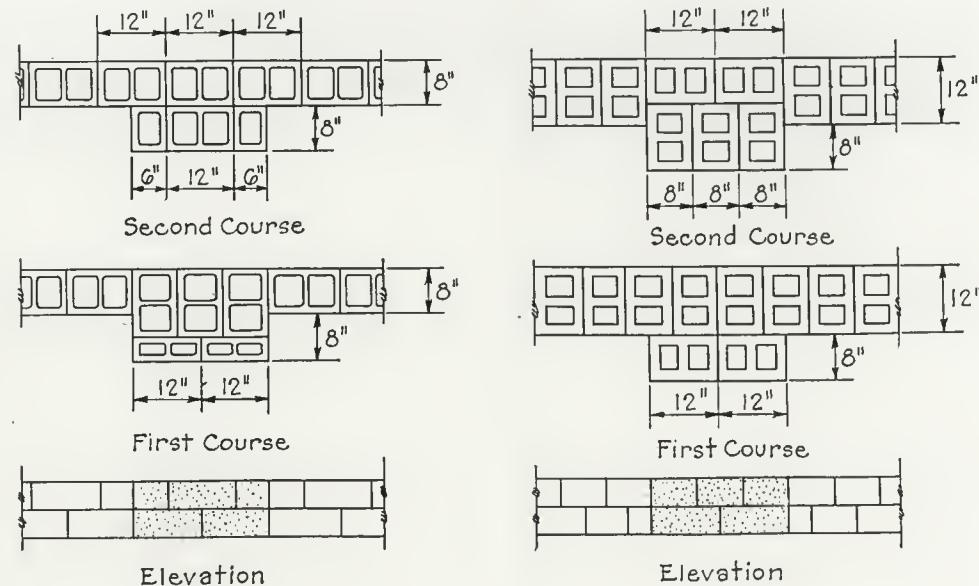
PILASTER CONSTRUCTION WITH CONCRETE BLOCK



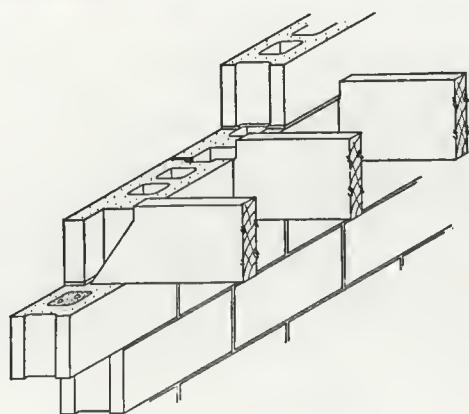
PILASTER CONSTRUCTION WITH CONCRETE TILE



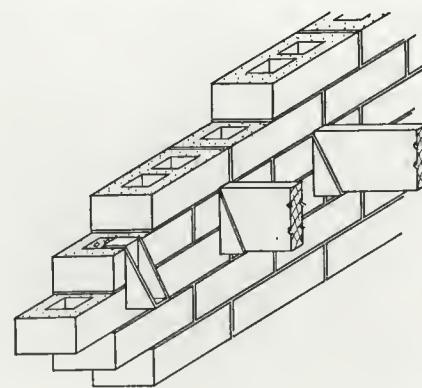
PILASTER CONSTRUCTION WITH CONCRETE BLOCK



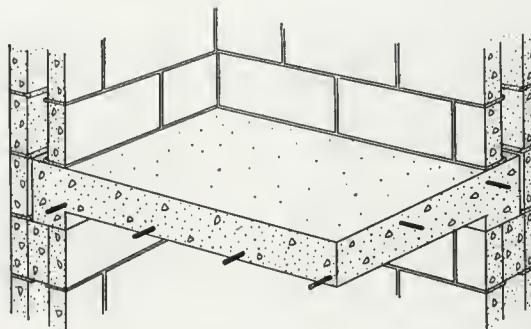
PILASTER CONSTRUCTION WITH CONCRETE TILE



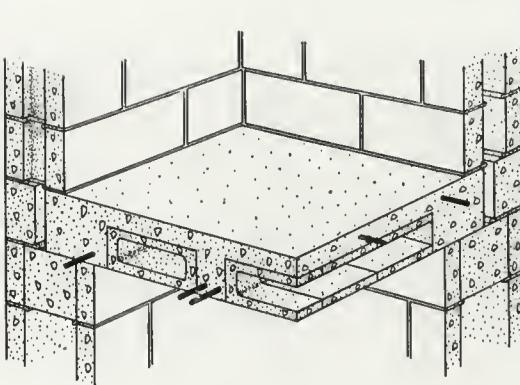
Wood Joists set into Block



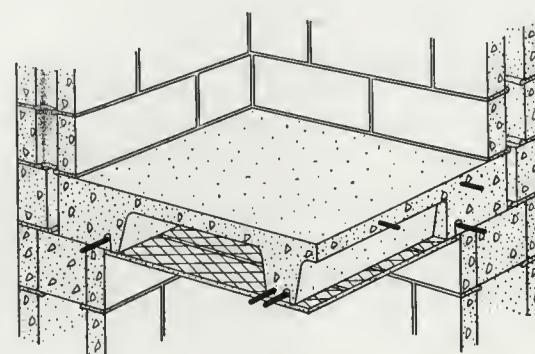
Wood Joists on Metal Hangers



Solid Slab Floor Construction

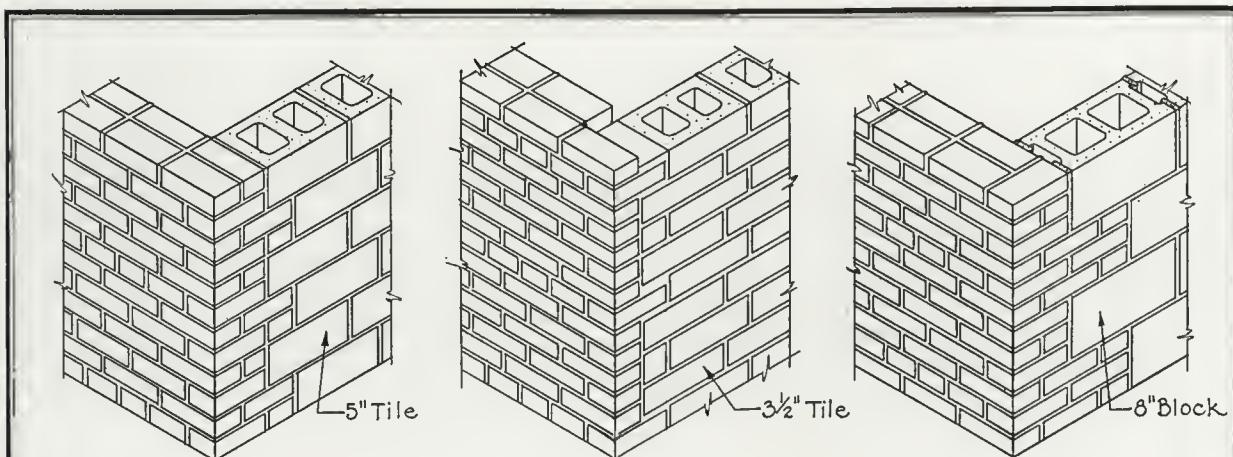


Tile and Joist Floor Construction

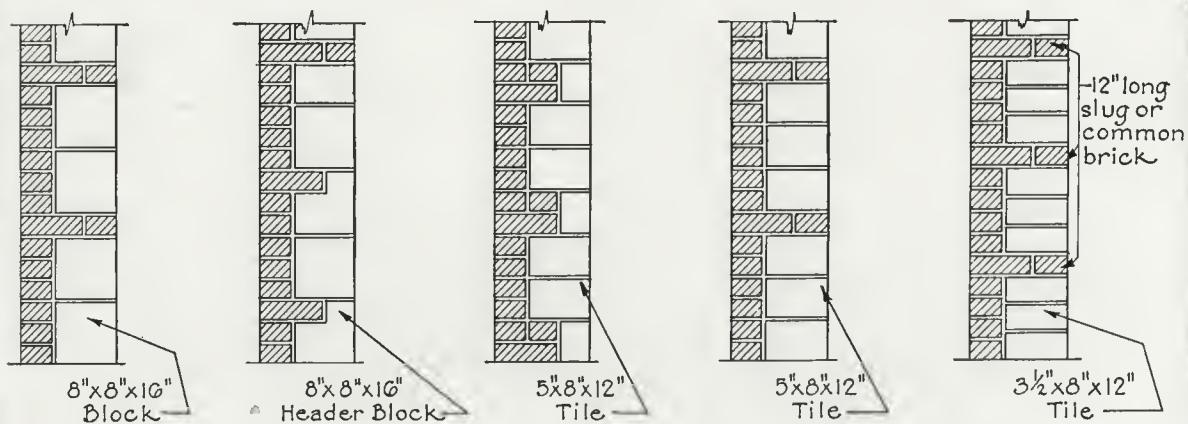


Ribbed Floor Construction

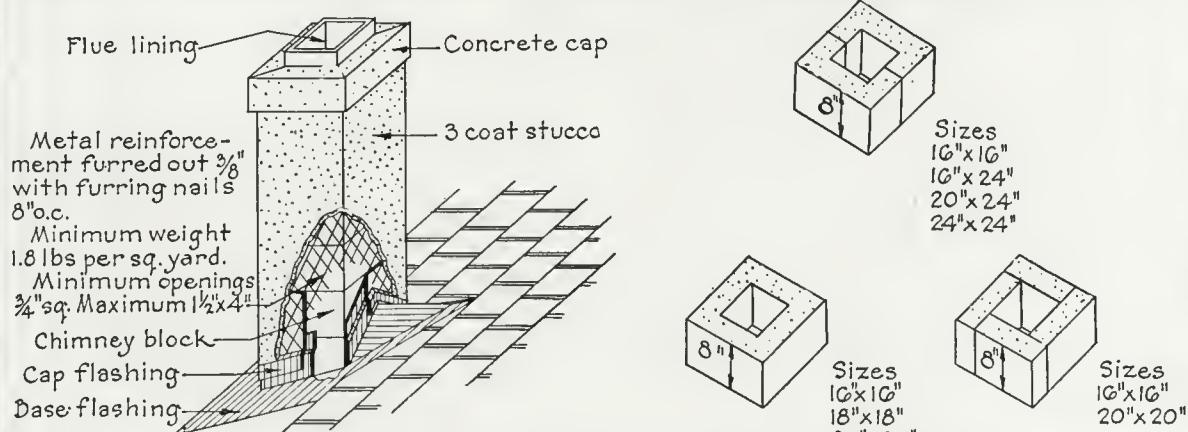
COMMON METHODS OF SUPPORTING FLOORS ON CONCRETE MASONRY WALLS



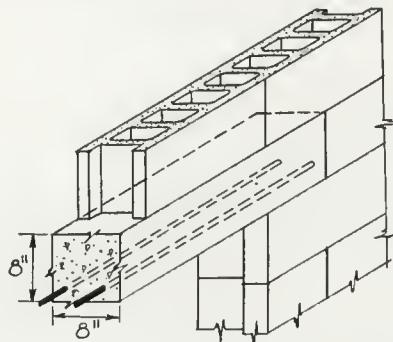
METHODS OF BONDING BRICK WALLS & CONCRETE MASONRY WALLS



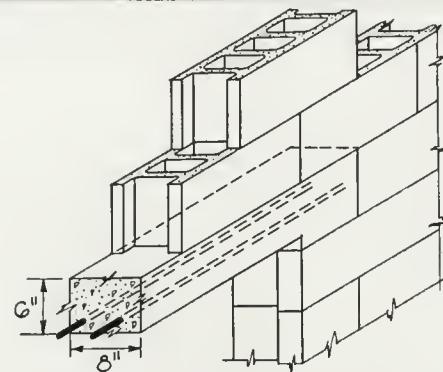
METHODS OF BONDING BRICK FACING TO CONCRETE MASONRY WALLS



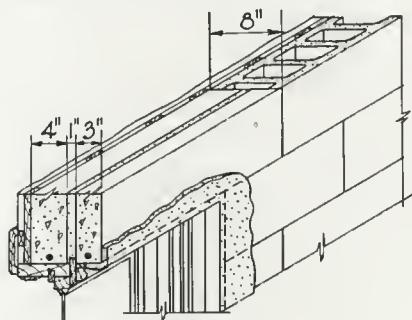
CONCRETE MASONRY CHIMNEY & SEVERAL TYPES OF CHIMNEY BLOCK



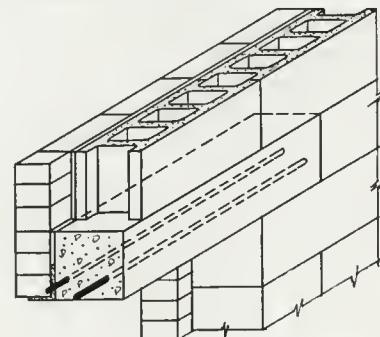
A Standard Concrete Lintel



Concrete Lintel with Rebate

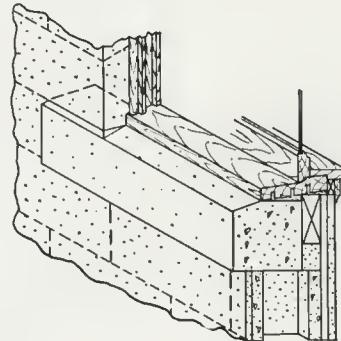


Split or Two Piece Lintel

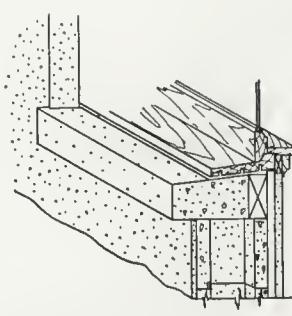


Combination Concrete and Angle-iron Lintel

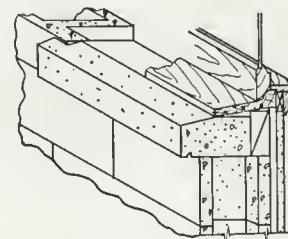
STANDARD CONCRETE LINTEL DETAILS



Lug Sill

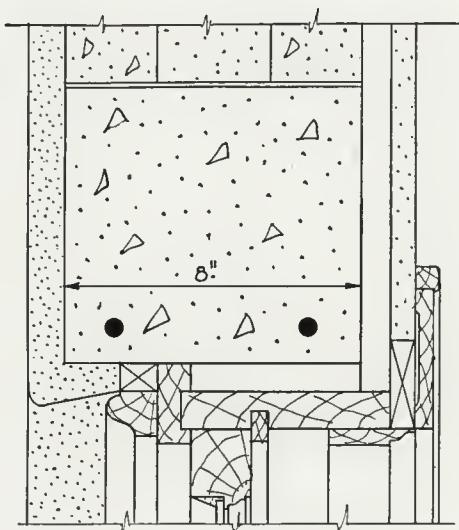


Standard Slip Sill

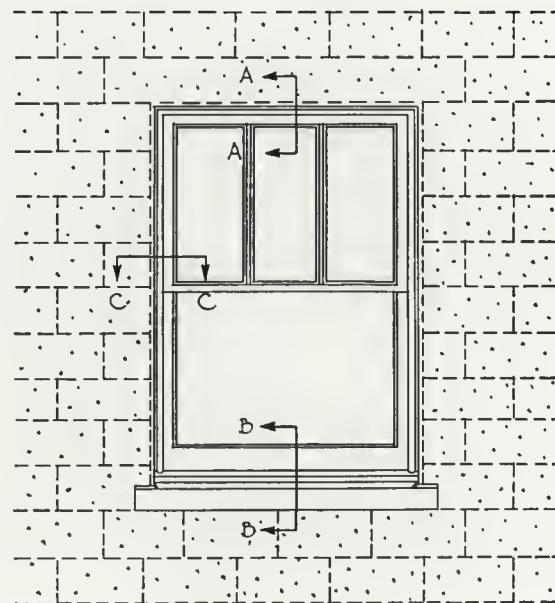


Special Slip Sill

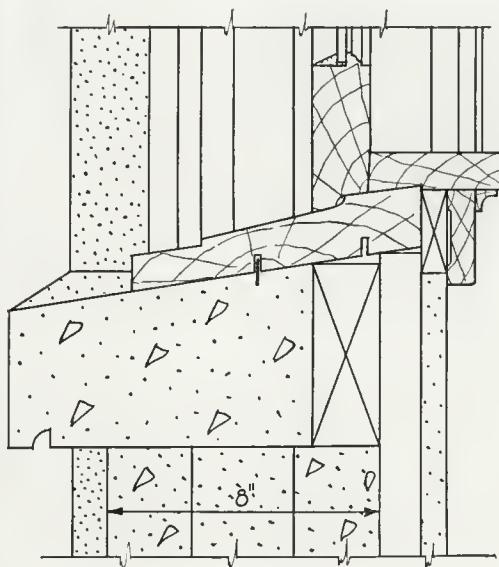
STANDARD CONCRETE SILL DETAILS



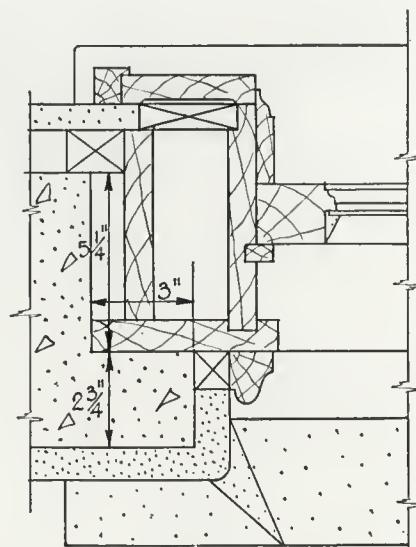
HEAD "A-A"



TYPICAL ELEVATION

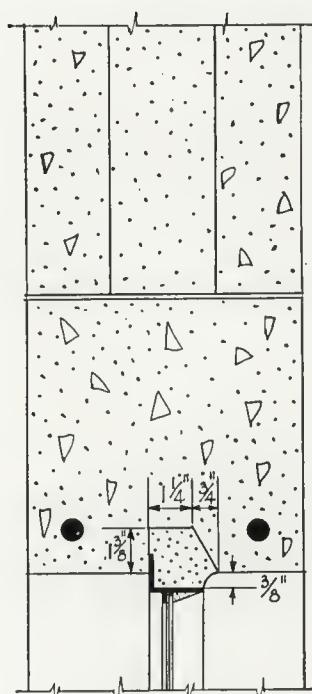


SILL "B-B"

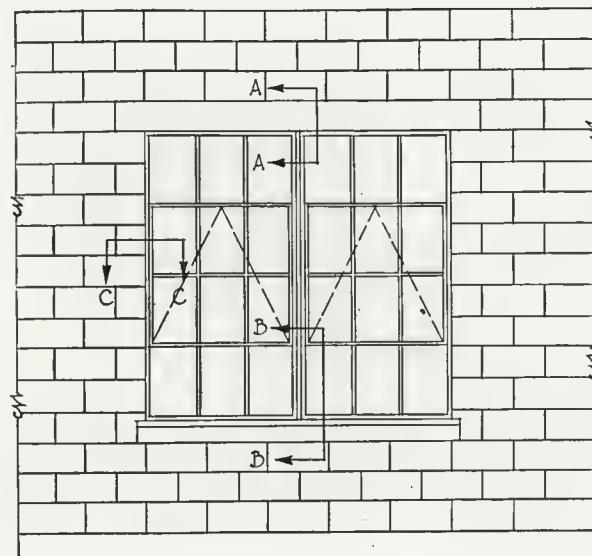


JAMB "C-C"

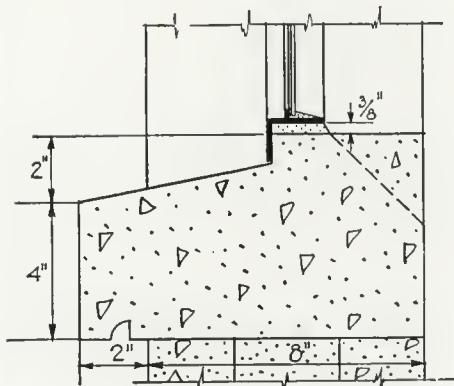
WINDOW DETAILS USING WOOD SASH



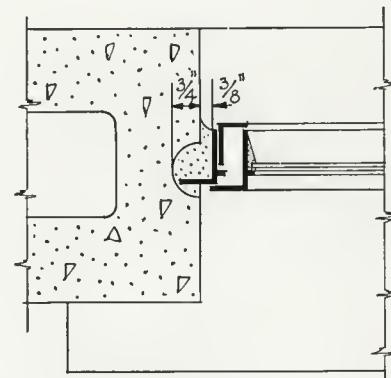
HEAD "A-A"



TYPICAL ELEVATION

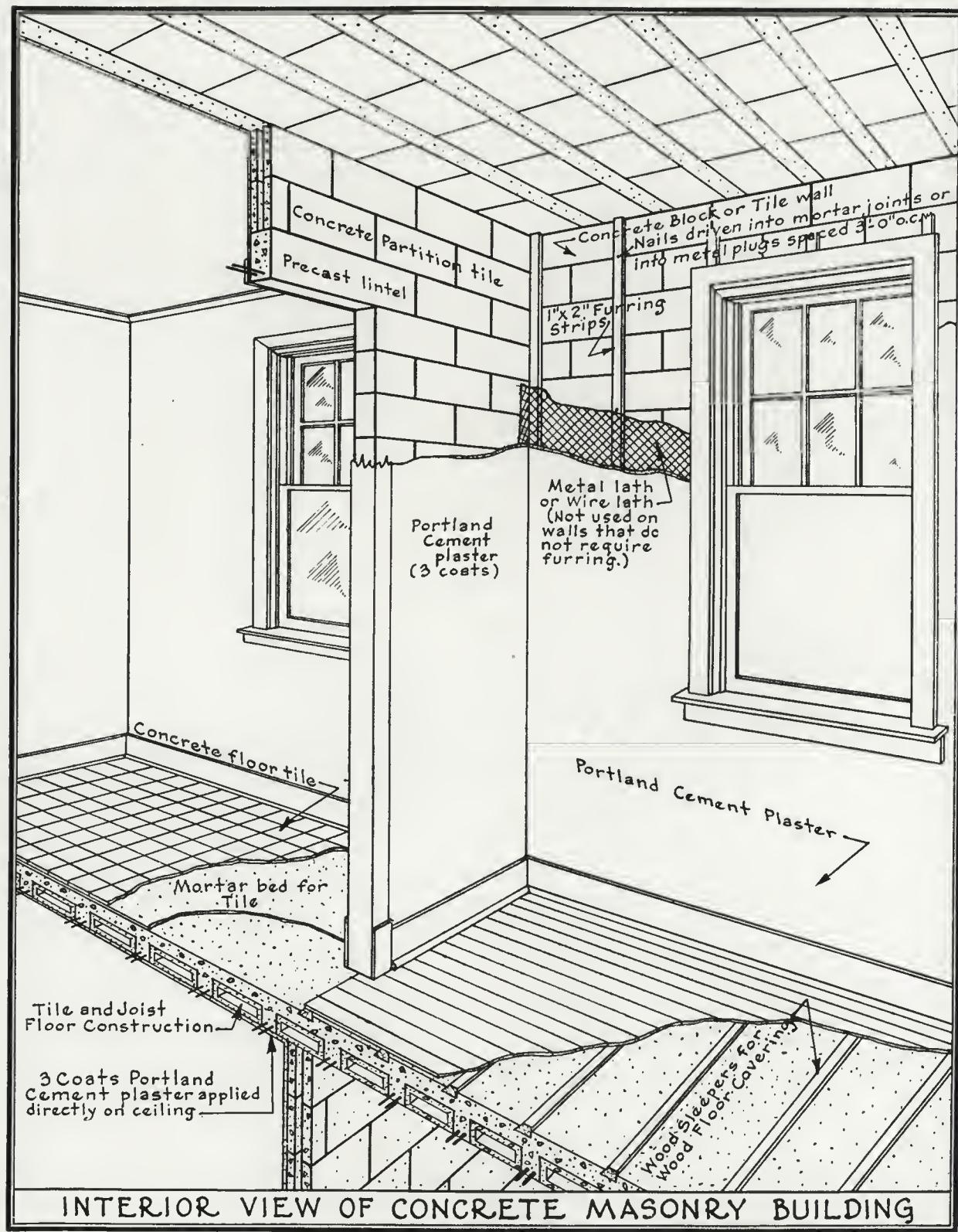


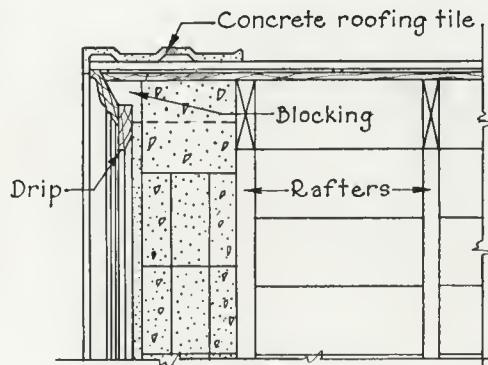
SILL "B-B"



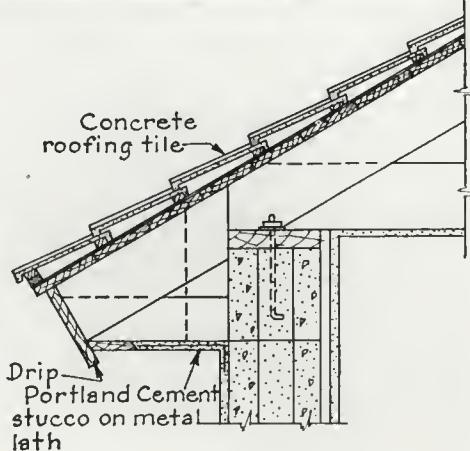
JAMB "C-C"

WINDOW DETAILS USING STEEL SASH

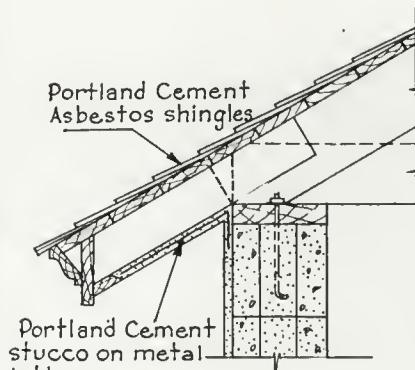




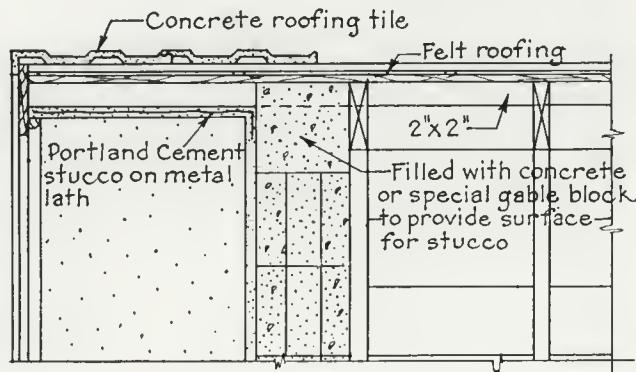
FLUSH GABLE END



EAVE SECTION

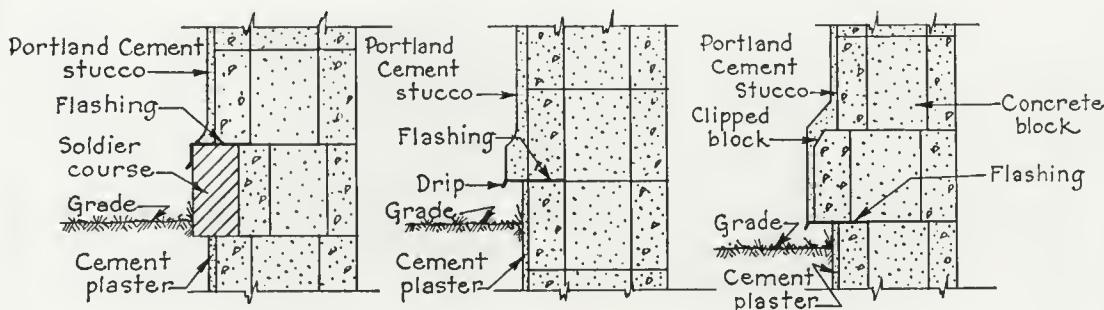


EAVE SECTION



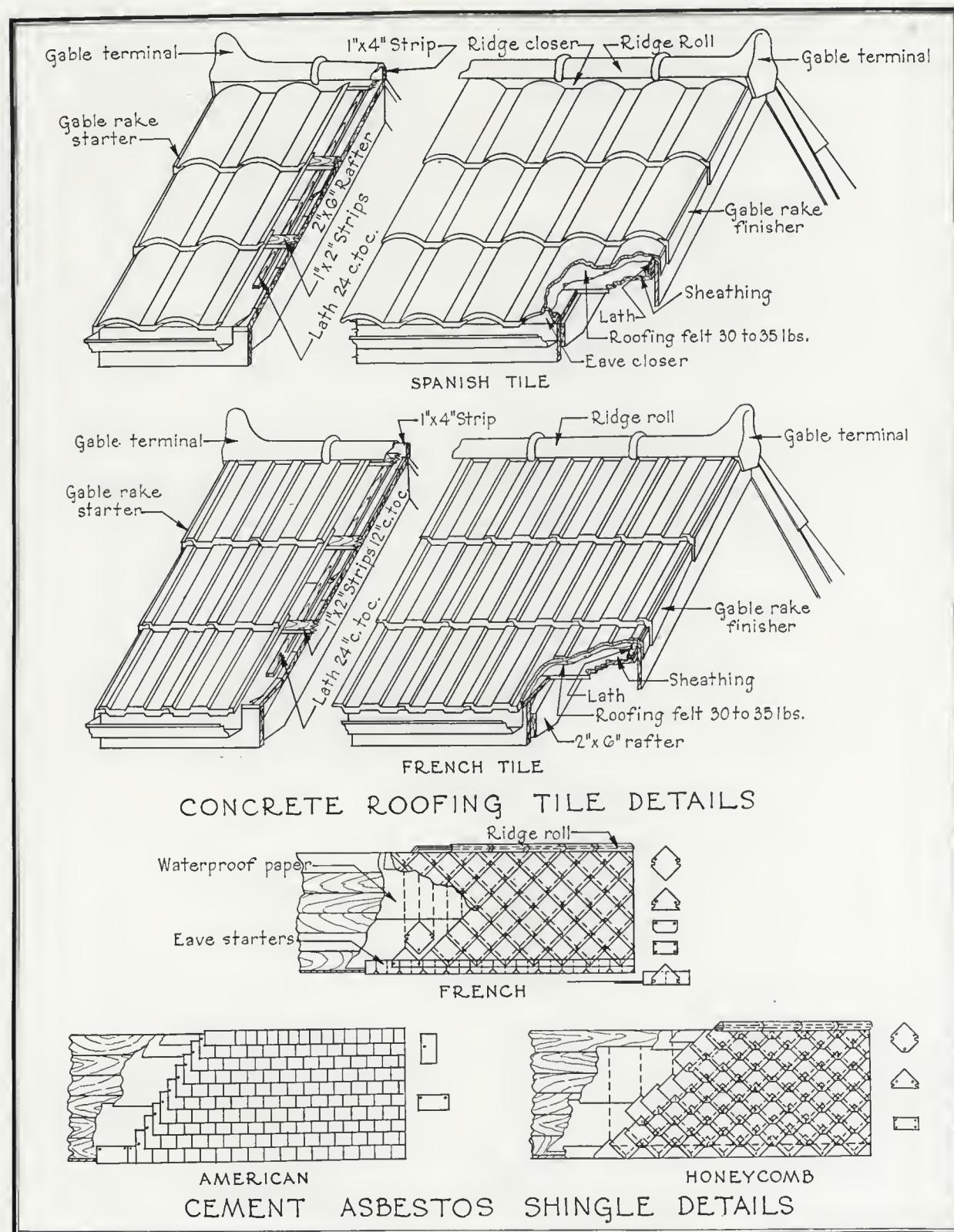
PROJECTING GABLE END

EAVE AND VERGE DETAILS



GRADE COURSES

USE SIMILAR CONSTRUCTION FOR CONCRETE TILE



PERSPECTIVE

Bars as shown in table
1/4" Temp. bars
12" o.c.

NOTES

1. Designed for concrete with an ultimate compressive strength of 2000 lb. per sq.in. ($7\frac{1}{2}$ gal. of water per sack of cement.)
2. Designed according to Building Regulations of the American Concrete Institute, 1928.
3. Loadings are those recommended for Residences by the Building Code Committee of the United States Department of Commerce.
4. Bearing partitions must be carried by walls or by beams and columns below.
5. Steel reinforcement to be tied at all intersections with No.18 black annealed wire.
6. Temperature bars may be replaced with mesh weighing not less than 25 lb. per 100 sq.ft.
7. Extra reinf. is required around stairwells.

LONGITUDINAL SECTION

8"
1/6 Span
Bend up each alternate bar
1/4 Span
When continuous, lap bars from opposite sides
1/4 Span
3/4" Clear
6"
5" Minimum bearing
1" Air Space
2" Veneer
Filled with concrete
Metal lath
Bars as shown in table
Filled with concrete
Metal lath
3/4" Clear
Center support may be bearing wall or girder as desired.

CROSS SECTION

Bend up each alternate bar
Temp bars 1/4" ϕ 12" o.c.
3/4" Clear
6"
1/4" Clear
Bars as shown in table
2" x 8"-5" from Inside of wall
Floor Panel
1" x G"
4" x 4" Posts
Max. spacing 2'-6"
Max. span 4'-0"
4" x 4"
Max. spacing 4'-0"
Max. span 4'-0"
Hardwood Wedges
Support posts on concrete floor or 2x10' Sill timbers.

REINFORCING BARS

Span	Spacing	Size
16'-0" to 14'-0"	5"	5/8" ϕ
14'-0" to 12'-0"	6"	1/2" ϕ
12'-0" to 10'-0"	8"	1/2" ϕ
10'-0" or less	12"	1/2" ϕ

FORMS

SOLID SLAB CONSTRUCTION

PERSPECTIVE

LONGITUDINAL SECTION

CROSS SECTION

NOTES

1. Designed for concrete with an ultimate compressive strength of 2000 lb. per sq.in. ($7\frac{1}{2}$ gal. of water per sack of cement.)
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5. Steel reinforcement to be tied at all intersections with No.18 black annealed wire.
6. Temperature bars may be replaced with mesh weighing not less than 25 lb. per 100 sq. ft.
7. Extra reinf. is required around stairwells.

SECTION

REINFORCING BARS

Span	Bars per Joist	
	Straight	Bent
16'-0"	1-3/4"	1-5/8"
15'-0"	1-3/4"	1-5/8"
14'-0"	1-5/8"	1-5/8"
13'-0" or less	1-1/2"	1-1/2"

RIBBED FLOOR CONSTRUCTION

PERSPECTIVE

NOTES

1. Designed for concrete with an ultimate compressive strength of 2000 lb. per sq.in. ($7\frac{1}{2}$ gal. of water per sack of cement.)
2. Designed according to Building Regulations of the American Concrete Institute, 1928.
3. Loadings are those recommended for Residences by the Building Code Committee of the United States Department of Commerce.
4. Bearing partitions must be carried by walls or by beams and columns below.
5. Steel reinforcement to be tied at all intersections with No.18 black annealed wire.
6. Temperature bars may be replaced with mesh weighing not less than 25 lb. per 100 sq. ft.
7. Extra reinf. is required around stairwells.

LONGITUDINAL SECTION

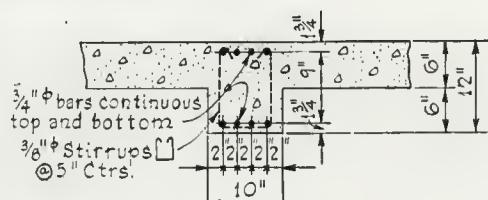
CROSS SECTION

REINFORCING BARS

Span	Bars per Joist	
	Straight	Bent
16'-0"	1-3/4"	1-5/8"
15'-0"	1-5/8"	1-5/8"
14'-0"	1-5/8"	1-5/8"
13'-0" or less	1-1/2"	1-1/2"

FORMS

TILE AND JOIST CONSTRUCTION

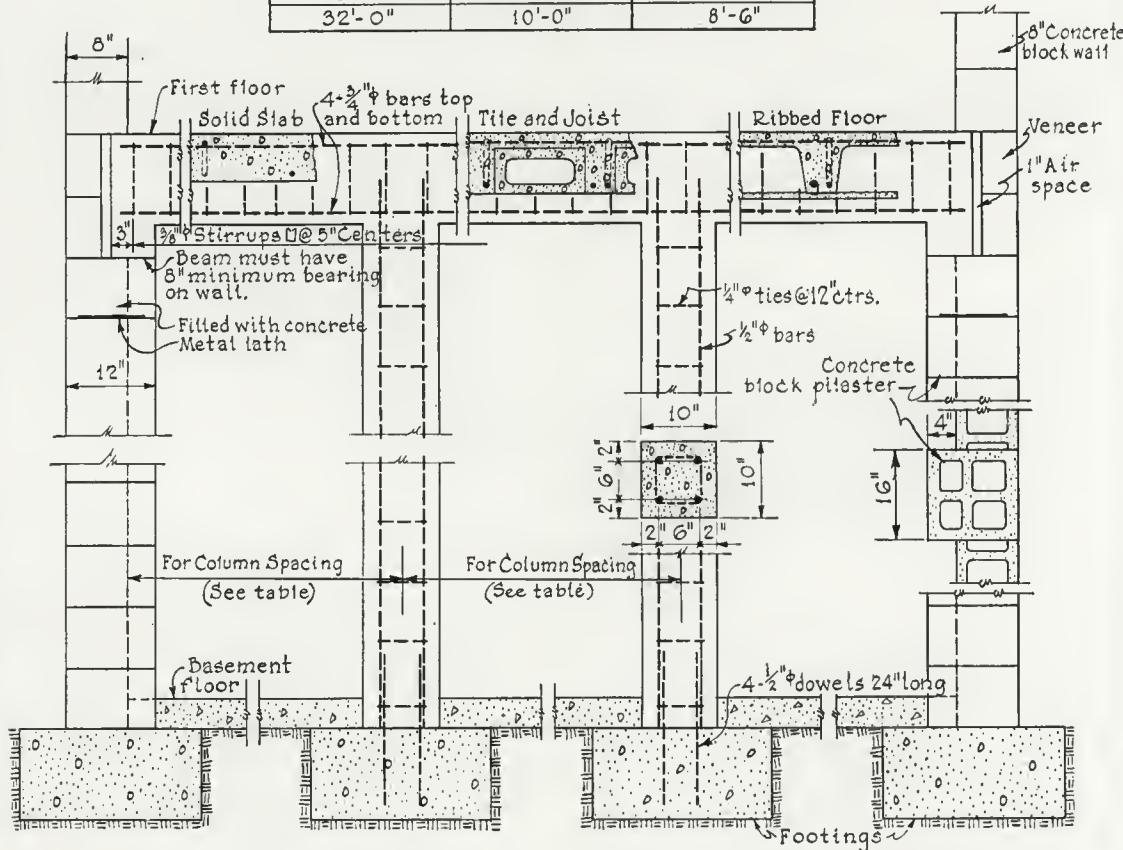


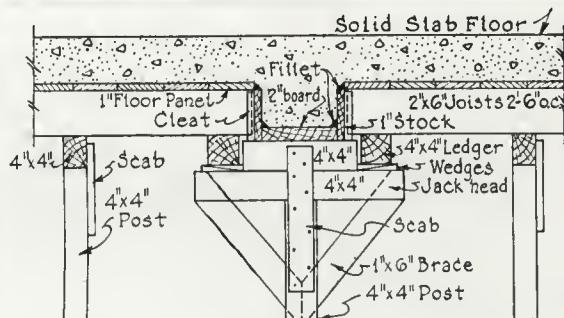
DETAIL OF BEAM
SOLID SLAB SHOWN

NOTES

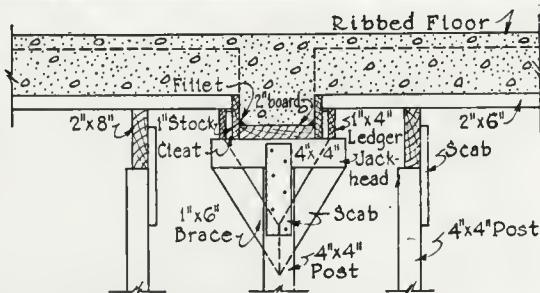
1. Designed for concrete with an ultimate compressive strength of 2000 lb. per sq.in. (7½ gal. of water per sack of cement.)
2. Designed according to Building Regulations of the American Concrete Institute, 1928.
3. Loadings are those recommended for Residences by the Building Code Committee of the United States Department of Commerce.
4. Steel reinforcement to be tied at all intersections with No.18 black annealed wire.

SUM OF TWO ADJACENT FLOOR SPANS	SPACING OF COLUMNS C.T.O.C.	
	Single story	Two story
20'-0"	12'-6"	10'-0"
24'-0"	11'-6"	9'-6"
28'-0"	10'-6"	9'-0"
32'-0"	10'-0"	8'-6"



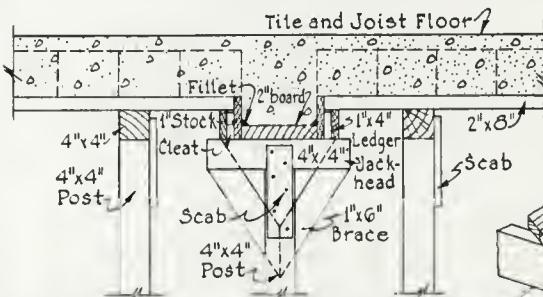


CROSS SECTION OF FORM FOR BEAM SHOWING SLAB FLOOR

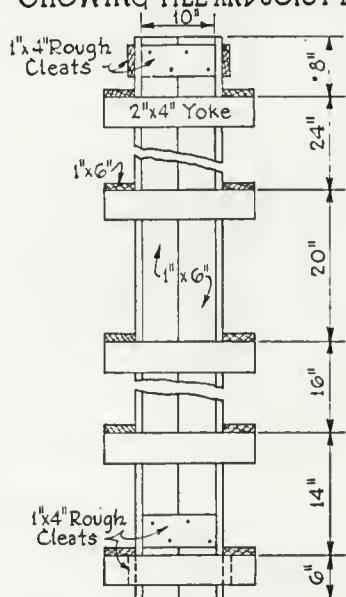


CROSS SECTION OF FORM FOR BEAM SHOWING RIBBED FLOOR

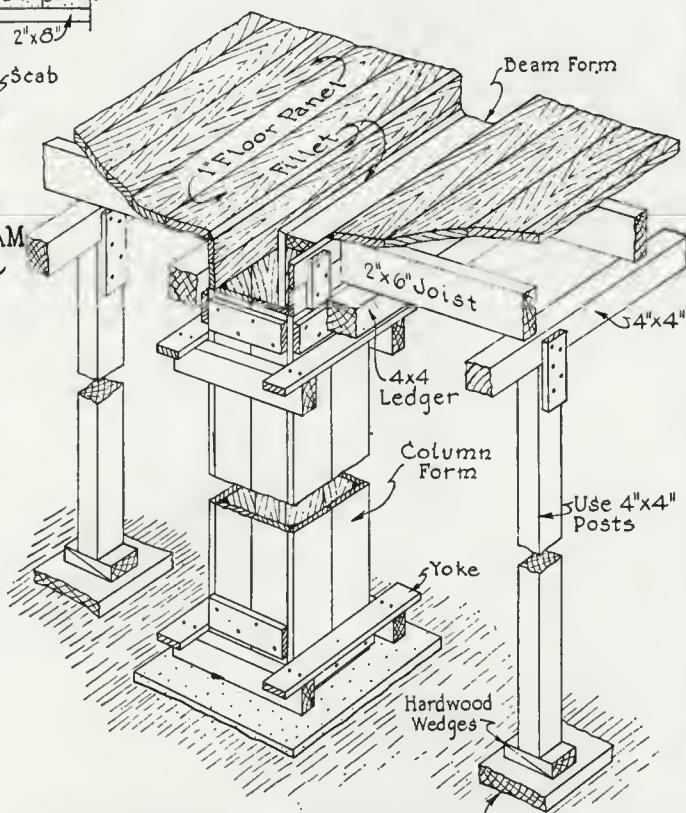
Note:- End sections of pans used at junction of joists with walls and girders.



CROSS SECTION OF FORM FOR BEAM SHOWING TILE AND JOIST FLOOR

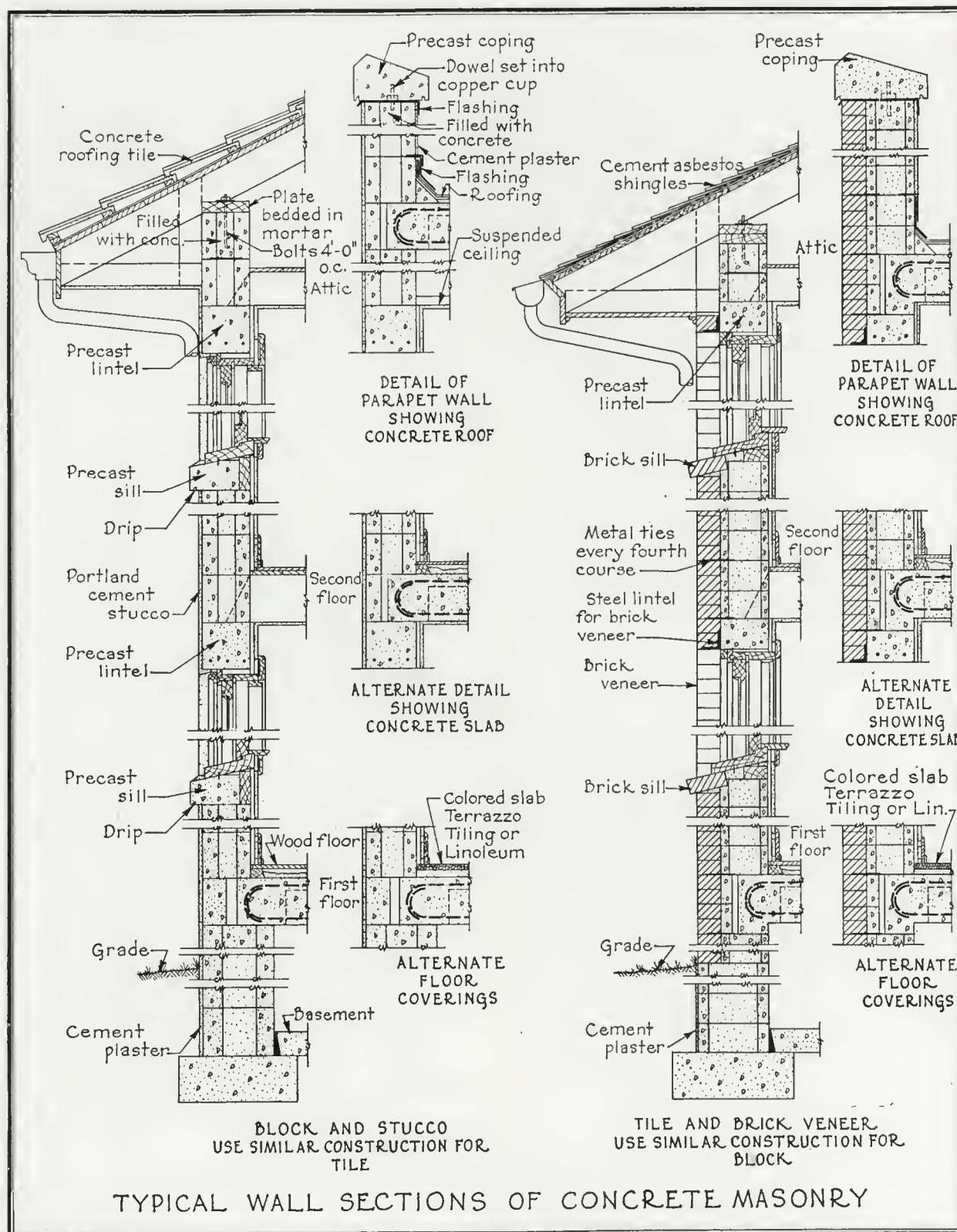


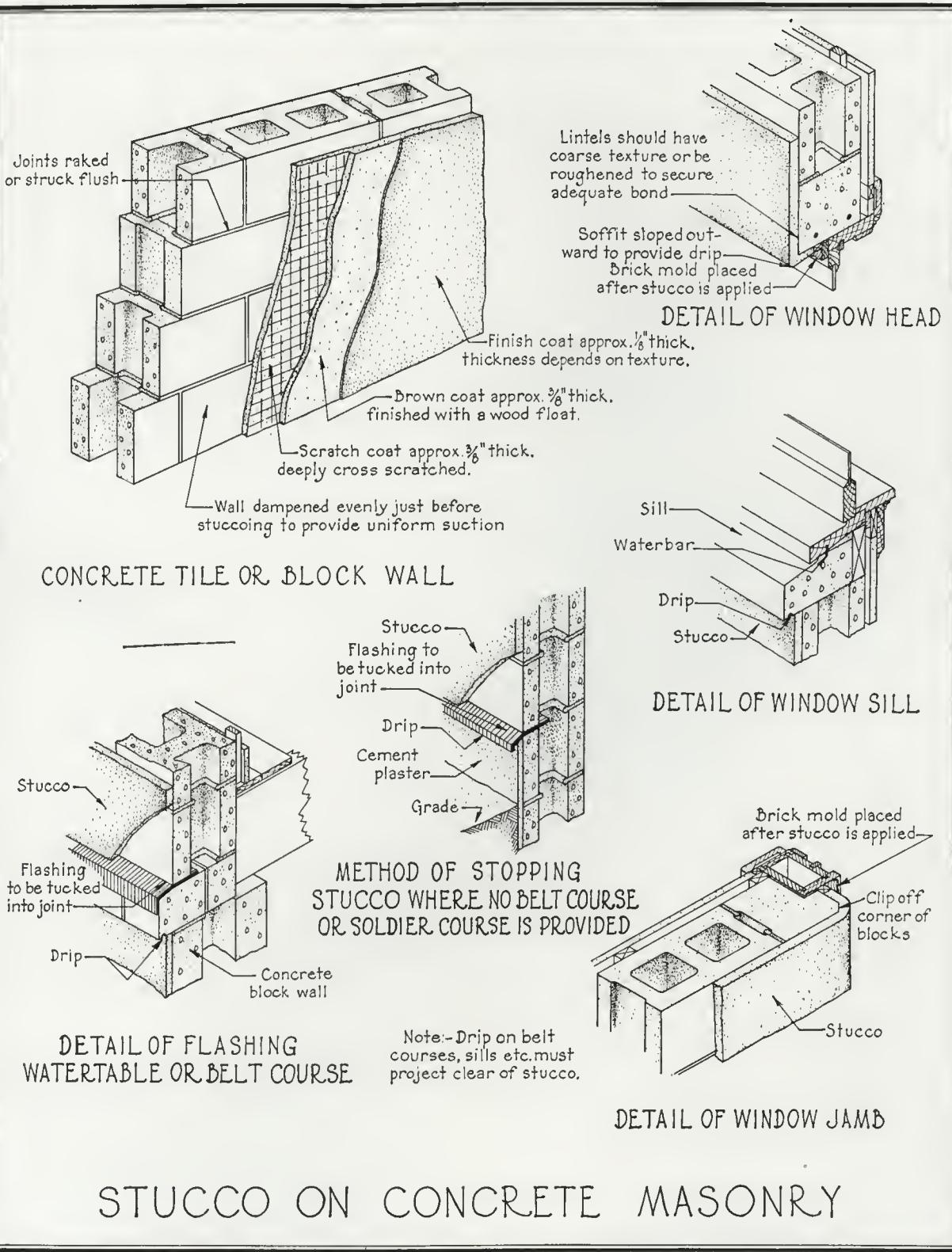
SPACING OF YOKES ON COLUMN FORM 7'-6" HIGH



VIEW SHOWING SLAB BEAM AND COLUMN FORM

FORM DETAILS FOR BEAMS AND COLUMNS





SPECIFICATIONS AND SUGGESTED ORDINANCE

American Concrete Institute Standard Specifications

FOR CONCRETE BUILDING BLOCK AND CONCRETE BUILDING TILE

Submitted by Committee P-1, on Standard Building Units, adopted as Tentative Specifications, February, 1928.

1. The purpose of these specifications is to define the requirements for concrete building block and concrete building tile to be used in construction.

2. The word "concrete" shall be understood to mean portland cement concrete.

Strength Requirements

3. The average compressive strength of three or more concrete block or concrete building tile in pounds per square inch of gross cross-sectional area as laid in the wall shall not be less than 700 pounds, no one unit falling below 600 pounds 28 days after being manufactured or when shipped.

Wherever concrete block or building tile are used to carry unusual heavy loads, the average compressive strength of three or more of these units 28 days after being manufactured or when shipped in pounds per square inch of gross cross-sectional area as laid in the wall shall be at least ten times the figured superimposed load to be applied.

Non-load-bearing concrete block and concrete tile shall have sufficient strength necessary to prevent excessive breakage during delivery and handling.

4. The gross cross-sectional area of a one-piece concrete block or tile shall be considered as the product of the length times the width of the unit as laid in the wall. No allowance shall be made for air spaces in hollow units. The gross cross-sectional area of each unit of a two-piece block or tile shall be considered the product of the length of the unit times one-half the thickness of the wall for which the two-piece block or tile is intended.

5. The compressive strength of the concrete in units of all classifications except non-load-bearing block shall be at least 1,000 lb. per sq. in., when calculated on the minimum cross-sectional area in bearing.

Absorption Requirements

6. Concrete building block and tile to be exposed to soil or weather in the finished work (without stucco, plaster or other suitable protective covering) shall meet the requirements of the absorption test.

7. All concrete building block and tile not covered by paragraph 6 need not meet an absorption requirement.

8. Concrete block and tile shall not absorb more than 10 per cent of the dry weight of the unit when tested as hereinafter specified, except when it is made of concrete weighing less than 140 pounds per cubic foot. For block or tile made with concrete weighing less than 140 pounds per cubic foot, the absorption in per cent by weight shall not be more than 10 multiplied by 140 and divided by the unit weight in pounds per cubic foot of the concrete under consideration.

Sampling

9. Specimens for tests shall be representative of the commercial product of the plant.

10. Not less than three and preferably five specimens shall be required for each test.

11. The specimens used in the absorption test may be used in the strength test.

METHODS OF TESTING

Strength Test

12. The specimens to be tested shall be carefully measured for overall dimensions of length, width and height.

13. Bearing surfaces shall be made plane by capping with plaster of paris or a mixture of portland cement and plaster which shall be allowed to thoroughly harden before the test;

14. Specimens shall be accurately centered in the testing machine;

15. The load shall be applied through a spherical bearing block placed on top of the specimen;

16. When testing other than rectangular block or tile care must be taken to see that the load is applied through the center of gravity of the specimen;

17. Metal plates of sufficient thickness to prevent appreciable bending shall be placed between the spherical bearing block and the specimen;

18. The specimen shall be loaded to failure;

19. The compressive strength in pounds per square inch of gross cross-sectional area is the total applied load in pounds divided by the gross cross-sectional area in square inches.

Absorption Test

20. The specimens shall be dried to constant weight at a temperature of from two hundred and twelve (212) to two hundred and fifty (250) degrees Fahrenheit and the weight recorded. After drying, the specimens shall be immersed in clean water at approximately seventy (70) degrees Fahrenheit for a period of twenty-four (24) hours. They shall then be removed, the surface water wiped off and the specimens re-weighed. The absorption is the weight of the water absorbed, divided by the weight of the dry specimen and multiplied by one hundred (100).

Weight of Concrete

21. The weight per cubic foot of the concrete in a block or tile is the weight of the unit in pounds divided by its volume in cubic feet. To obtain the volume of the unit, fill a vessel with enough water to immerse the specimen. The greatest accuracy will be obtained with the smallest vessel in which the specimen can be immersed with its length vertical. Mark the level of the water, then immerse the saturated specimen and weigh the vessel. Draw the water down to its original level and weigh the vessel again. The difference between the two weights divided by 62.5 equals the volume of the specimen in cubic feet.

American Concrete Institute Specifications

FOR CONCRETE BRICK

Submitted by Committee P-1, on Standard Building Units. Adopted as Tentative Specifications, February, 1926.

GENERAL

1. The purpose of these specifications is to define the requirements for concrete brick to be used in construction.
2. The word "concrete" shall be understood to mean portland cement concrete.

Strength Requirements

3. The average compressive strength of concrete brick 28 days after being manufactured or when shipped shall not be less than 1,500 lb. per sq. in. of gross cross-sectional area as laid in the wall, and the compressive strength of any individual brick shall not be less than 1,000 lb. per sq. in. of gross cross-sectional area as laid in the wall.

4. The gross cross-sectional area of a brick shall be considered as the product of the length times the width of the unit as laid in the wall.

Absorption Requirements

5. Concrete brick shall not absorb more than 12 per cent of the dry weight of the brick when tested as hereinafter specified except when they are made of concrete weighing less than 125 lb. per cu. ft. For brick made of concrete weighing less than 125 lb. per cu. ft., the average absorption in per cent by weight shall not be more than 12 multiplied by 125 and divided by the unit weight in pounds per cubic foot of the concrete under consideration.

Sampling

6. Specimens for tests shall be representative of the commercial product of the plant.
7. Five specimens shall be required for each test.
8. The specimens used in the absorption test may be used for the strength test provided they have been

dried at approximately 70 degrees Fahrenheit for not less than three days.

METHODS OF TESTING

Strength Test

9. The specimens to be tested shall be carefully measured for over-all dimensions of length, width and thickness.
10. Bearing surfaces shall be made plane by capping with plaster of paris or a mixture of portland cement and plaster which shall be allowed to thoroughly harden before the test.
11. Specimens shall be accurately centered in the testing machine.
12. The load shall be applied through a spherical block placed on top of the specimen.
13. Metal plates of sufficient thickness to prevent appreciable bending shall be placed between the spherical bearing block and the specimen.
14. The specimen shall be loaded to failure.
15. The compressive strength in pounds per square inch of gross cross-sectional area is the total applied load in pounds divided by the gross cross-sectional area in square inches.

Absorption Test

16. The specimens shall be dried to constant weight at a temperature of from 212 degrees to 250 degrees F. and the weight recorded. After drying, the specimens shall be immersed in clean water at approximately 70 degrees F. for a period of 24 hours. They shall then be removed, the surface water wiped off and the specimens re-weighed. The absorption is the weight of the water absorbed, divided by the weight of the dry specimen and multiplied by one hundred.

Suggested Specifications for the Application of Portland Cement Stucco on Concrete Block and Tile Walls

CONCRETE BLOCK AND TILE

Concrete block and tile should meet the requirements of the Standard Specifications of the American Concrete Institute. (See page 40.) Sample block from those delivered to the building may be tested by the architect if desired, and if the samples fail to meet the requirements, the entire shipment may be rejected. The tests to be made at a recognized testing laboratory in the methods prescribed by the American Concrete Institute.

PORLAND CEMENT STUCCO

The whole of the outside walls, including porches, piers, etc., as indicated, shall be covered with portland cement stucco applied directly to the concrete block or tile.

Masonry Walls

Concrete block and tile walls shall be rigid and constructed upon solid footings. All units shall be laid in portland cement mortar, mixed in the proportions of 1 part portland cement, 1 part commercially hydrated or well slaked lime, and 6 parts of sand. All joints to be cut flush with the wall surface. The surface of block and tile to be stuccoed should be rough and of coarse texture. The surface on which stucco is to be applied shall be clean, free from all dust, dirt or loose particles. Wood lintels over wall openings shall not be used. Monolithic concrete walls or lintels shall be roughened by hacking, wire brushing or other effective means, or covered with metal reinforcement.

Chimneys, and areas not of concrete block or tile such as the soffits of eaves, ceilings of porches, metal flashings and other parts so shown, should be covered with metal reinforcement consisting of large mesh expanded metal or wire fabric. The metal reinforcement shall be galvanized or made of a special grade of rust-resisting steel and weigh not less than 1.8 pounds per square yard. Openings shall be not smaller than $\frac{3}{4}$ -inch square, nor larger than 2 inches square. The metal reinforcement shall be furred out $\frac{3}{8}$ -inch with furring nails on 8-inch centers.

Hangers, fasteners, trim or other fixed supports or projections of any kind shall be in place before stucco is applied. Flashing shall be so designed and placed that water cannot get behind the stucco. Flashing must be a high-grade rust-resisting material.

MATERIALS

Cement

Portland cement shall conform to the requirements of the latest standard specifications of the American Society for Testing Materials.

Aggregate

Aggregate shall consist of clean sand or screenings from crushed stone, graded from fine to coarse. For the base coats (scratch and brown) all aggregates shall pass the No. 8 sieve. Fineness of the aggregate for the finish coat should be such as to produce the texture specified. (For the finish coat, aggregate may have to be finer than for the base coats, the degree of

fineness depending upon the type of finish desired. For some finishes it is desirable that all of the material pass the No. 14 sieve, while for others up to 15 per cent may be retained on that sieve.) All aggregate must be free from loam, silt and vegetable matter.

Hydrated Lime

Hydrated lime shall meet the requirements of the Standard Specifications of the American Society for Testing Materials and shall be used in quantity not to exceed one-fifth the volume of cement.

Water

Only water that is fit to drink shall be used. It must be free from oil, acids, alkali and vegetable matter.

Coloring Materials

Only highest grade mineral pigments that are fully guaranteed by the manufacturer to be unaffected by lime, cement or weather shall be used as coloring matter and in amounts not to exceed 6% of the weight of the cement. In job-mixed stucco proper proportions to produce a desired shade shall be subject to the approval of the architect. A factory prepared finish coat stucco of the specified finish may be used upon the approval of the architect.

CONSTRUCTION

Proportions

The proportions for all coats shall be 1 sack of portland cement to 3 cu. ft. of aggregate to which may be added hydrated lime in an amount not exceeding one-fifth the volume of cement. In these proportions 1 cu. ft. (1 sack) of cement weighs 94 lbs. net and 1 cu. ft. of hydrated lime weighs 40 lbs.

Mixing

The ingredients of the stucco shall be thoroughly mixed, preferably in a machine mixer of the rotating drum type, for at least five minutes after all materials are in the drum. The quantity of mixing water shall be determined by trial and thereafter measured in proper proportion.

Application of the Scratch Coat

The scratch coat shall be approximately $\frac{3}{8}$ -inch thick and carried the full length of the wall or to natural breaking points like doors, windows or belt courses. The wall surface must be clean and dry, but dampened evenly just before applying the scratch coat to provide uniform suction. Before it hardens the scratch coat shall be cross-scratched to provide mechanical key for the brown coat.

The scratch coat shall be kept damp at least two days following its application. The wall shall not be soaked but given only as much water as it will readily absorb. It shall then be allowed to become thoroughly dry before applying the brown coat.

Application of the Brown Coat

Before starting to apply the brown coat, the surface of the scratch coat shall be dampened evenly to provide uniform suction. The brown coat shall be approximately $\frac{3}{8}$ -inch thick. It shall be brought to a true and

SURFACE FINISHES FOR PORTLAND CEMENT STUCCO

It is recommended that the architect bring to his client's attention the possibilities in portland cement stucco textures and colors. Samples of textures and colors should be submitted by competent stucco contractors and used as the basis for bids on the particular project under consideration. The following paragraph indicates briefly some of the more popular textures available, the number of finishes being limited only by the skill of the plasterer.

Colonial

The finishing coat, after being brought to a smooth even surface and when slightly hardened should be rubbed with a circular motion of the float with the addition of a little sand to roughen the surface slightly.

California

This texture consists of a rough cast surface partially smoothed by rubbing it with a piece of carpet or burlap before hardening has entirely taken place. The effect will then be similar to the walls

of ancient adobe block covered with plaster, with the undulating surfaces revealing their contours.

Italian

This is a rough cast texture, spots of mortar being thrown onto the floated finished surface in various amounts, irrespective of placing. The steel trowel is then lightly run over the hillocks, trowelling smoothly in spots the variations in the surface. This treatment gives the effect of depth and beauty which may be further enhanced by the use of several colors for polychrome effect.

English Cottage

Small dabs of mortar, placed on the steel trowel, are feathered off the edge of the trowel in short upward strokes, to the right or left, in indefinite direction and to avoid the appearance of a design. The irregular weaving can be varied by the amounts of mortar used on the trowel, the length of the strokes and the pressure applied, and constitute a very popular treatment adaptable to the smaller residence.

even surface and then left rough enough to provide a bond for the finish coat. A wood float shall be used to finish the brown coat.

The brown coat shall be kept damp at least two days. It shall not be soaked but given only as much water as it will readily absorb. It shall then be allowed to become thoroughly dry before applying the finish coat.

Application of the Finish Coat

Before starting to apply the finish coat, the second or brown coat shall be dampened evenly to provide uniform suction. The finish coat shall be thick enough to produce the texture desired. Whenever possible it shall be applied from top to bottom in one operation.

The finish coat shall be kept damp at least two days following application.

Freezing

Stucco shall not be applied when the temperature is below 32 degrees Fahrenheit, unless protected and kept at a temperature around 50 degrees F. for at least 48 hours after application.

Curing

Each coat of stucco should be kept damp continuously for at least two days. The wall should not be soaked but given only as much water as it will readily absorb. To prevent excessive evaporation from stucco on the sunny or windward side of buildings in hot, dry weather, wet tarpaulins should be fastened over the outside of the wall and kept moist.

After the damp curing period, each stucco coat should be allowed to dry thoroughly before the next coat is applied.

Recommended Building Ordinance for Concrete Block and Tile *

GENERAL REQUIREMENTS

Section 1—Definition

Concrete block and tile are defined, for the purpose of this ordinance, as hollow or two-piece masonry building units, made of portland cement, water and aggregate consisting of sand, gravel, crushed stone, crushed air-cooled blast furnace slag, burned shale, cinders, or other suitable materials.

Section 2—Materials and Proportions

The portland cement shall conform with the standard specifications for portland cement adopted by the American Society for Testing Materials.

The aggregate must be clean and free from harmful substances.

Materials shall be so proportioned that the concrete block or tile will meet the requirements hereinafter specified.

* Building code committees contemplating the adoption of this proposed ordinance are urged to make use of the Portland Cement Association's building code service.

Section 3—Identification of Concrete Block and Tile

Each concrete block or tile in the city of _____ shall bear a permanent mark or brand identifying the manufacturer of the unit. A copy of said brand or mark shall be on file with the Building Inspector.

Section 4—Tests of Concrete Block

All tests of masonry materials required by this ordinance shall be made at a laboratory approved by the building inspector and shall be paid for by the manufacturer or his selling agent. Test samples shall be selected and sealed for identification by the Building Inspector. Samples must be taken from regular commercial stocks representing the average quality of the product made by the manufacturer. The laboratory making the tests shall furnish the Building Inspector with a certified copy of the results of each test. Check tests may be required by the Building Inspector whenever, in his opinion, it seems advisable. If the first tests after the original application for approval indicate failure of the product to meet the requirements speci-

fied in this ordinance additional tests may be made after the methods of manufacture have been altered with the view of producing masonry units that will conform to said requirements.

Section 5—Standards of Quality

Before approval is given the product of any manufacturer, compression and absorption tests made at a laboratory approved by the building inspector must show that the material meets the requirements of this ordinance. Units which will be protected in the finished work with stucco, plaster or other suitable protective covering need not be tested for absorption. The ultimate compressive strength of hollow and two-piece units 28 days old or when delivered to the building site must average not less than 700 lb. per sq. in. of the gross cross-sectional area of the unit as used in the wall. No unit shall test less than 600 pounds per square inch over the gross area. The gross cross-sectional area of hollow building units shall be considered the product of the length by the width of the unit. The gross cross-sectional area of a two-piece concrete building unit shall be one-half the product of the length of the unit by the width of the wall for which the units are intended.

Where the absorption test is required the average amount of water absorbed in 24 hours by units 28 days old or when delivered to the building site shall not exceed 14 pounds per cubic foot of actual volume of concrete in the unit.

At least three samples shall be selected of each product to be tested for either compressive strength or absorption.

Laboratory tests and certification of results shall be made at least every six months on samples of the product made by every manufacturer. Rejected block may be used in non-bearing partitions if specifically approved by the Building Inspector.

A plant for the production of concrete block or tile must be established for operation before official tests are made.

These tests shall be made in accordance with the standard methods prescribed by the American Concrete Institute in its Standard Specifications for Concrete Building Block and Concrete Building Tile.

DETAILS OF CONSTRUCTION

Section 6—Use

Concrete block and tile which have the approval of the Building Inspector may be used in building construction wherever solid masonry is permitted, subject only to the restrictions contained in this ordinance.

Section 7—Mortar

Either portland cement mortar composed of 1 part portland cement to not more than 3 parts of sand with an allowable addition of hydrated lime not to exceed 15 per cent of the cement by volume, or cement-lime mortar mixed in proportions of 1 part portland cement, 1 part slaked lime (lime putty) or dry hydrated lime, and not more than 6 parts sand, shall be used for walls of hollow concrete unit construction.

Section 8—Lateral Support

Walls of concrete block or tile shall be supported at right angles to the wall face at intervals not exceeding sixteen times the wall thickness in top stories, or eighteen times the wall thickness elsewhere. Such lateral support may be in the form of cross walls, piers, or buttresses when the limiting distance is horizontal,

or by floors when the limiting distance is vertical. Sufficient bonding or anchorage shall be provided between the wall and the supports to resist the assumed wind force acting in an outward direction. Piers or buttresses relied upon for lateral support shall have sufficient strength and stability to transmit the wind force, acting in either direction, to the ground. When walls are dependent on floors for their lateral support provision shall be made in the building to transfer the lateral force resisted by all floors to the ground.

Section 9—Working Stresses

The maximum allowable compressive stresses in masonry of concrete block or concrete tile due to combined live and dead loads shall not exceed 80 pounds per square inch of gross sectional area, when laid with portland cement mortar, and 70 pounds per square inch of gross sectional area when laid with cement lime mortar.

Section 10—Thickness and Height of Exterior Walls Other Than in Skeleton Construction

Walls of concrete block or tile shall not exceed 50 feet in height above the top of foundation walls.

The thickness of walls shall be sufficient at all points to keep the stresses due to combined live and dead loads for which the building is designed within the limits prescribed by Section 9.

The minimum thickness of exterior walls of concrete block or tile shall be 12 inches for the uppermost 35 feet of their height, and at least 16 inches for the remaining lower portion; except that the top story wall of a building not exceeding three stories or 40 feet in height, or the wall of a one-story commercial or industrial building, may be 8 inches thick, provided that the roof beams are horizontal; and except that exterior walls of one and two-family dwellings may be 8 inches thick for the uppermost 20 feet. When gable construction is used for such dwellings an additional 5 feet is permitted to the peak of the gable.

Where walls are stiffened at distances not greater than 12 feet by cross walls or by internal or external returns at least 2 feet deep, the thickness may be 12 inches throughout, except that the top story wall, or the uppermost 20 feet of walls of one and two-family dwellings, may be 8 inches as previously provided.

Section 11—Bond

Where two or more hollow concrete units are used to make up the thickness of a wall, the inner and outer courses shall be bonded at vertical intervals not exceeding three courses by lapping at least 4 inches over the unit below.

Section 12—Beam Supports

Suitable provision shall be made at each line of floor beams in hollow walls or walls of hollow concrete units to shut off the spaces above from those below, and to insure good bearing for beams and uniform distribution of loads.

Section 13—Piers

Hollow concrete block or tile shall not be used for isolated piers unless solidly filled with concrete. The unsupported height of such piers shall not exceed ten times their least horizontal dimension.

Section 14—Chases and Recesses

There shall be no chases in 8-inch walls or within the required area of any pier, and no chase in any wall or pier shall be deeper than $\frac{1}{3}$ the wall thickness. No horizontal chase shall exceed 4 feet in length, nor

shall the horizontal projections of any diagonal chase exceed 4 feet.

Recesses for stairways or elevators may be left in walls, but in no case shall the walls at such points be less than the required thickness of the walls of the fourth story above the ground floor unless reinforced by additional piers, by steel or reinforced concrete girders, or steel or reinforced concrete columns and girders, securely anchored to the walls on each side of such recesses. Recesses for alcoves and similar purposes shall have not less than 8 inches of material at the back. Such recesses shall be not more than 8 feet in width and shall be arched over or spanned with lintels.

The aggregate area of recesses and chases in any wall shall not exceed $\frac{1}{4}$ the whole area of the face of the wall in any story.

Chases and recesses shall not be cut in walls of concrete block or tile but may be built in. No chases or recesses shall be permitted in fire walls that will reduce the thickness below the minimum specified in this ordinance.

Openings for doors and windows shall have well-buttressed arches or lintels of masonry or metal with bearing at each end of not less than 4 inches on the wall. On the inside of openings less than 4 feet wide, in which the thickness of arches and lintels is less than that of the wall supported, timber may be used, which will rest at each end not more than 2 inches on the wall and be chamfered or cut to serve as arch centers.

VENEERED WALLS WITH CONCRETE MASONRY BACKING

Section 15—Quality of Materials

Stone or architectural terra cotta, ashlar, or other approved masonry material used for veneering, shall be not less than 3 inches thick. In stone ashlar each stone shall have a reasonably uniform thickness, but all stones need not necessarily be the same thickness.

Section 16—Working Stresses

The maximum allowable compressive stresses on the backing of veneered walls, due to combined live and dead loads, shall not exceed those prescribed in Section 9 for concrete block or tile masonry. In no case shall the veneering be considered a part of the wall in computing the strength of bearing walls, nor shall it be considered a part of the required thickness of the wall.

Section 17—Attachment of Veneering

When walls are veneered with brick, terra cotta, stone or concrete trimstone, the veneering shall be tied into the backing either by a header for every 300 square inches of wall surface, or by substantial non-corrodible metal wall ties spaced not farther apart than 1 foot vertically and 2 feet horizontally. Headers shall project at least $3\frac{1}{4}$ inches into the backing, and anchors shall be of substantial pattern. When veneering is used special care shall be taken to fill all joints flush with mortar around wall openings.

Section 18—Height of Veneered Walls

Veneered walls shall not exceed 40 feet in height above foundations.

FACED WALLS WITH CONCRETE MASONRY BACKING

Section 19—Quality of Materials

Materials used for facing shall be not less than $3\frac{3}{4}$ inches thick, and in no case less in thickness than $\frac{1}{8}$ the height of the unit, excepting that spandrel and other recessed panels, when approved, may be higher than eight times their thickness, provided they are of the minimum thickness required.

Section 20—Working Stresses

The maximum allowable compressive stresses on faced walls due to combined live and dead loads shall not exceed those prescribed in Section 9 for Concrete Block or Tile Masonry. Where bonded to the backing as provided in Section 22, the whole cross section of the facing may be considered in computing bearing strength.

Section 21—Thickness

Faced walls shall be not less in thickness than is required for masonry walls of the type which forms the backing. Where bonded to the backing as provided in Section 22 the facing may be considered a part of the wall thickness.

Section 22—Bond

Brick facing shall be bonded to walls of concrete block or tile with at least one header course in every six courses, or there shall be at least one full length header in every 72 square inches of wall surface.

Stone ashlar facing shall have at least 20 per cent of the superficial area not less than $3\frac{1}{4}$ inches thicker than the remainder of the facing to form bond stones, which shall be uniformly distributed throughout the wall.

When some stone in every alternate course are at least $7\frac{1}{2}$ inches thick, bonded into the backing at least $3\frac{1}{4}$ inches, and at least 20 per cent of the superficial area of the wall is constituted of such bond stone uniformly distributed, the ashlar facing may be counted as part of the wall thickness. Every stone not a bond stone and every projecting stone shall be securely anchored to the backing with substantial non-corrodible metal anchors.

FIRE WALLS, FIRE DIVISION WALLS, AND PARTITIONS

Section 23—Fire Walls of Concrete Block or Concrete Tile

A fire wall is a wall which subdivides a building to restrict the spread of fire, by starting at the foundation and extending continuously through all stories to and above the roof.

Fire walls of concrete block or concrete tile shall be not less than 16 inches thick in any part, except that for residential buildings they may be not less than 12 inches thick throughout. No fire walls of the above types shall be broken into, subsequent to erection, for the insertion of structural members.

Where combustible or unprotected steel building members frame into hollow party or fire walls of thickness not greater than 12 inches, they shall not project more than 4 inches into the wall and shall be so spaced that the distance between embedded ends is not less than 4 inches. The space above, below, and between them shall be filled solidly with mortar, concrete or equivalent fire-resistive material, to a depth of not less than 4 inches on all sides of the members.

All open cells of concrete block or tile occurring at wall ends shall be filled solid with concrete for at least a depth of 6 inches, or closure tile set in the opposite direction shall be used.

Party walls which function also as fire walls shall conform to requirements for fire walls.

Section 24—Fire Division Walls

A fire division wall is a wall which subdivides a fire-resistant building to restrict the spread of fire, but is not necessarily continuous through all stories nor extended through the roof.

Fire division walls of concrete block or tile shall be not less than 12 inches thick in any part, and for buildings of storage and heavy manufacturing occupancy they shall be not less than 16 inches thick throughout.

Section 25—Parapet Walls

In commercial or industrial buildings and in residential buildings over three stories high, all fire or party walls shall project above the roof as parapets.

Where not otherwise specified, parapet walls shall be at least 32 inches high, but not higher than four times their thickness unless laterally supported. They shall be at least as thick as the top story wall, except that they need not in any case be more than 12 inches thick.

In residential buildings not more than three stories high parapet walls shall extend through combustible roofs to a height of at least 12 inches above the roof. All parapet walls shall be coped.

Section 26—Bearing Partitions

All interior bearing walls, except fire walls, fire division walls and party walls, are considered as bearing partitions.

Where not utilized as party, fire or fire division walls, concrete block or concrete tile bearing partitions shall be not less in thickness than 1/18 of the height between floors or floor beams.

Section 27—Non-bearing Partitions

Non-bearing partitions of concrete block or concrete tile shall be built solidly against floor and ceiling construction below and above, and shall not exceed the following unsupported heights:

Thickness Exclusive of Plaster Inches	Maximum Unsupported Height Feet
3	12
4	15
6	20
8	25

FOUNDATION WALLS

Section 28—Foundation Walls

Concrete block foundation walls shall be not less in thickness than walls immediately above them and in no case less than 12 inches thick, except that when the enclosure is not excavated, they may be 8 inches thick if included within the allowable heights of 8-inch walls.

When the stresses due to earth pressure and superimposed building loads exceed the maximum working stress specified in Section 9 for Concrete Masonry and the additional stresses are not otherwise provided for, the wall thickness shall be increased to bring them within these limits. Foundation walls for wood frame construction shall extend at least 8 inches above the adjoining ground surface. All foundation walls shall extend below the level of frost action.

SKELETON CONSTRUCTION

Section 29—Panel and Enclosure Walls

Concrete block or tile panel walls in buildings of skeleton construction shall be not less than 8 inches thick. Enclosure walls shall be not less than 8 inches thick or less in thickness than 1/20 the horizontal distance between anchors.

PROCEDURE FOR APPROVAL

Section 30—Approval and Fee

All concrete block and tile used in the city of _____ shall be approved in writing by the Building Inspector. Such written approval may be obtained upon application for the same and submitting the certificate of tests in accordance with the provisions of this ordinance. When the block or tile are found to comply with all the requirements of this ordinance the written approval shall be issued upon payment of \$25 to the City Treasurer, which amount is to be credited to the Building Department. Each approval shall expire on the last day of January of each year. The name of the person, firm or corporation and its officers who manufacture the block or tile must be placed on file with the Building Inspector for his records. All changes of ownership or management of any plant whose product is approved under this ordinance must be reported in writing to the Building Inspector.

If at any time after the approval of the product of any manufacturer the Building Inspector finds it necessary to require subsequent check tests in accordance with this ordinance, and such tests disclose that said product does not meet the requirements of this section, the Building Inspector shall forthwith revoke the approval previously given.

**Data on Various Concrete Masonry Walls
per 100 sq. ft. of Wall Area**

Concrete Block

DESCRIPTION	Wall Thickness	Weight Per Unit (Lb.)	Number of Units (Per 100 square feet of wall area)	Mortar* (Cu. Ft.)	Weight Lb. (Per 100 square feet of wall area)
8"x 8"x16" 33% Voids	8"	55	110	5.00	6300
8"x 8"x16" 40% Voids	8"	50	110	5.75	5810
8"x 8"x12" 40% Voids	8"	38	146	6.00	5857
8"x12"x16" 40% Voids	12"	85	110	8.25	9775
8"x 3"x16"	3"	20	110	2.25	2315
9"x 3"x18"	3"	26	87	2.00	2365
12"x 3"x12"	3"	23	100	2.00	2403
8"x 3"x12"	3"	15	146	2.50	2318
8"x 4"x16" Partition block	4"	28	110	3.00	3234
9"x 4"x18" 33% Voids	4"	35	87	2.75	3186
12"x 4"x12"	4"	31	100	2.75	3242
8"x 4"x12"	4"	21	146	3.50	3246
8"x 6"x16"	6"	42	110	7.50	5006

Cinder Block

8"x 8"x16" 40% Voids	8"	32	110	5.75	3830
8"x12"x16" 40% Voids	12"	50	110	8.25	5925
8"x 4"x16" Solid	4"	25	110	4.00	2950
8"x 4"x16" Partition block,	4"	15	110	3.00	1805
8"x 6"x16" Hollow	6"	25	110	7.50	3136

Haydite Block

8"x 8"x16" 40% Voids	8"	26	110	5.75	3170
8"x12"x16" 40% Voids	12"	37	110	8.25	4495
8"x 4"x16" 40% Voids	4"	13	110	3.00	1630

Concrete Tile

5"x 8"x12" 50% Voids	8"	19.9	220	9.00	4840
5"x 4"x12" 50% Voids	4"	9.9	220	6.00	2485
5"x 6"x12" 50% Voids	6"	14.9	220	7.50	3664
3 1/2"x8"x12"	8"	16.5	300	7.75	5360
3 1/2"x4"x12"	4"	8.5	300	7.00	2910
3 1/2"x6"x12"	6"	12.5	300	7.50	4085

Cinder Tile

5"x 8"x12" 50% Voids	8"	12.9	220	9.00	3300
5"x 4"x12"	4"	6.5	220	6.00	1740
5"x 6"x12"	6"	10.3	220	7.50	2650

Concrete Brick

2 1/4"x3 3/4"x8"	8"	5.	1300	12.66	9000
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*These figures are based on 3/8-inch mortar joints and 50 per cent wastage. Weight of mortar assumed at 103 pounds per cu. ft.

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